APPENDIX A: WSDOT Type II Retrofit Program

A component of this analysis is to meet the requirements of WSDOT's Type II retrofit wall program. This program proposes noise abatement for highways where neighborhoods existed before I-5 was constructed and where noise levels are high enough to warrant consideration of noise reduction. The retrofit program is not tied to highway improvement projects that add lanes or change roadway alignment. The Type II program is funded independently. The Ship Canal Bridge study area is a retrofit project.

To qualify for the retrofit list the buildings for the sensitive receivers must have been built prior to May 1976; the neighborhood must have impacted residents with noise levels at 66 dBA or higher; and impacted residents must live within 500 feet of the edge of roadway.

Based on the evaluation of the I-5 Ship Canal Bridge and the noise impacts on 1,200 residences and residential equivalencies within 500 feet of I-5, this location ranked tenth out of 72 locations statewide.

The development and implementation of Type II projects are not mandatory Federal requirements. However, WSDOT maintains a retrofit list that dates back to the 1970's. Currently there are 72 locations statewide awaiting barriers that are ranked by a formulation of a number of factors. This list assures that neighborhoods that were not considered for noise abatement prior to the establishment of federal noise regulations still have the opportunity for mitigation.

As a voluntary program projects on this list are built in order to provide greater noise abatement as funding allows. Retrofit projects are prioritized in an order reflecting traffic noise levels, number of homes benefiting, cost and the achievable reductions. For communities to be eligible for a Type II project they must meet the conditions of Federal Highway Administration (FHWA) Directive D22-22 (Appendix A), 23 CFR 772 (Appendix B) and section 339 (b)(2) of the "National Highway System Designation Act of 1995".

APPENDIX B: Noise Basics

Characteristics of Noise

Sound

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure. This is called *sound pressure*. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA, 1974). Magnitude measures the physical sound energy in the air. The range of magnitude, from the faintest to the loudest sound that the ear can hear, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness, compared to physical sound measurement, refers to how people subjectively judge a sound and this varies from person to person. Noise is unwanted sound.

Sound Characteristics and Human Response

Humans respond to a sound's frequency or pitch. The human ear is very effective at perceiving sounds that have a frequency between approximately 1,000 and 5,000 Hz, and human hearing decreases outside this range. Environmental noise is composed of many frequencies, each occurring simultaneously at its own sound-pressure level. Frequency weighting, which is applied electronically by a sound level meter, combines the overall sound frequency into one sound level that simulates how an average person hears sounds. The commonly used frequency weighting for environmental noise is A-weighting (dBA), which is most similar to how humans perceive sounds of low to moderate magnitude.

How Humans Perceive Noise

Because of the logarithmic decibel scale, a doubling of the noise sources (e.g., the number of cars operating on a roadway) increases noise levels by three dBA. A ten-fold increase in the number of noise sources will add 10 dBA. As a result, a source that emits a sound level of 60 dBA, combined with another source of 60 dBA, yields a combined sound level of 63 dBA (not 120 dBA). The human ear can barely perceive a three dBA increase, but a five or six dBA increase is readily noticeable and sounds as if the noise is about one and one-half times as loud. To most listeners, a ten dBA increase appears to be a doubling in noise level.

Factors Affecting Traffic Noise

Noise levels from traffic sources depend on volume, speed, and the type of vehicle. Generally, an increase in volume, speed, or vehicle size increases traffic noise levels. Vehicular noise is a combination of sounds from the engine, exhaust, and tires. Other conditions affecting traffic noise include defective mufflers, steep grades, terrain, vegetation, distance from the roadway, and shielding by barriers and buildings.

Environmental Effects on Noise

Noise levels decrease with distance from the source. For a line source such as a roadway, noise levels decrease three dBA over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass) for every doubling of distance between the source and the receptor. For a point source such as construction, noise levels decrease between 6 dBA and 7.5 dBA for every doubling of distance from the source.

The type of terrain and the elevation of the receiver relative to the noise source can greatly affect the propagation of noise. Level ground is the simplest scenario: sound travels in a straight line-of-sight path between the source and receiver (Figure 3).

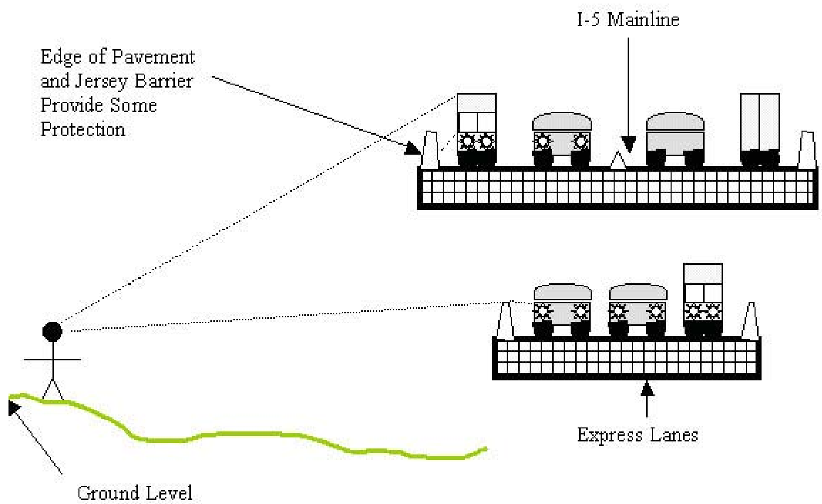


Figure 1: Elevated noise source

If the source is depressed or the receiver is elevated, noise generally travels directly to the receiver. Noise levels may be reduced in cases where the terrain crests between the source and receiver, resulting in a partial noise barrier near the receiver. If the source is elevated or the receiver is depressed, sound often is reduced at the receiver. The edge of the roadway can act as a partial noise barrier, blocking some sound transmission between the source and receiver (Figure 3). Even a short barrier (e.g., a solid concrete Jersey-type safety barrier) can reduce noise levels. Breaking the line of sight between the receiver and the noise source often results in a noise reduction of approximately five dBA.

Atmospheric Conditions

Atmospheric conditions such as wind, temperature, humidity, and precipitation, are not normally a major factor in most traffic noise analysis projects. However, in the present study the bridge structure is elevated above the community. Therefore, prevailing winds from the northwest during the winter months and the southwest during the summer months tend to carry more of the traffic noise farther east of the bridge and bend the sound waves towards the ground on the east side

Sound Level Descriptors

A widely used descriptor for environmental noise is the equivalent sound level (L_{eq}). The L_{eq} can be considered a measure of the average sound level during a specified period of time. It is a measure of total noise, or a summation of all sounds during a time period. It places more emphasis on occasional high noise levels that accompany general background sound levels. L_{eq} is defined as the constant level that, over a given period of time, transmits to the receiver the same amount of acoustical energy as the actual time-varying sound. For example, two sounds, one containing twice as much energy but lasting only half as long, have the same L_{eq} noise levels. L_{eq} measured over a one-hour period is the hourly L_{eq} [L_{eq}(h)] this is used for highway noise impact and abatement analyses.

Short-term noise levels (e.g., a single truck passing by) are described by either the total noise energy or the highest instantaneous noise level occurring during the event. The sound exposure level (SEL) is a measure of total sound energy from an event, and is useful in determining what the L_{eq} will be over a period in time when several noise events occur. The maximum sound level (L_{max}) is the greatest short-duration sound level that occurs during a single event. L_{max} is related to impacts on speech interference and sleep disruption. In comparison, L_{min} is the minimum sound level during a period of time.

People will generally find a moderately high, constant sound level more tolerable than a quiet background level interrupted by frequent high-level noise intrusions. An individual's response to sound depends greatly upon the range that the sound varies in a given environment. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in a relatively quiet area. In light of this subjective response, it is often useful to look at a statistical distribution of sound levels over a given time period in addition to the average sound level. Such distributions identify the sound level exceeded and the percentage of time it is exceeded. Therefore, it allows for a more thorough description of the range of sound levels during a given measurement period. These distributions are identified with an L_n, where *n* is the percentage of time that the levels are exceeded. For example, the L_{10} level is the sound level that is exceeded 10 percent of the time.

Effects of Noise

Environmental noise at high intensities directly affects human health by causing hearing loss. Prolonged exposure to very high levels of environmental noise can cause hearing loss. The EPA has established a protective level of 70 dBA L_{eq}, below which hearing is conserved for exposure over a 40-year period (U.S. EPA, 1974). Although scientific evidence is not currently conclusive, noise is suspected of causing or aggravating other diseases. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. The FHWA noise abatement criteria are based on speech interference, which is a well documented impact that is relatively reproducible in human response studies.

Noise Regulations and Impact Criteria

Applicable noise regulations and guidelines provide a basis for evaluating potential noise impacts. For Type I state and federally funded highway projects, traffic noise impacts occur when predicted LA_{eq} (h) sound levels approach or exceed the noise abatement criteria (NAC) established by the FHWA, or substantially exceed existing sound levels (U.S. Department of Transportation, 1973, Noise Abatement Council). The term "substantially exceed" is defined by WSDOT as an increase of 10 dBA or more to be a substantial increase.

The FHWA noise abatement criteria specify exterior LA_{eq}(h) noise levels for various land activity categories (Table 1). For receptors where serenity and quiet are of extraordinary significance, the noise criterion is 57 dBA. For residences, parks, schools, churches, and similar areas, the noise criterion is 67 dBA. For developed lands, the noise criterion is 72 dBA. WSDOT considers a noise impact to occur if predicted LA_{eq}(h) noise levels approach within one dBA of the noise abatement criteria in Table 6. Thus, if a noise level were 66 dBA or higher, it will approach or exceed the FHWA noise abatement criterion of 67 dBA for residences.

Table 1: FHWA Noise Abatement Criteria

Activity Category	L_{eq} (h) (dBA)	Description of Activity Category
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need, and where preserving these qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	-	Undeveloped lands.
E	52 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.
Source: U.S. Department of Transportation, 1982.		

Land use in the study area includes residential, parks, commercial, industrial, schools and some undeveloped uses (see Figure 1 for map showing quadrants). In the southwest quadrant of the study area land use is primarily residential in the south, changing to a mix of residential, commercial, and industrial uses farther north. There are several apartments under the bridge at Eastlake Avenue E. and E. Allison and several houseboats located along the waterfront.

The Southeast quadrant of the study area is almost exclusively residential. There are some residences that have been converted to commercial use near Franklin Avenue East. North of Franklin to Eastlake Avenue East land use is mixed with residential and commercial uses. North of Eastlake Avenue E. land use is commercial with several residential uses including houseboats under the bridge.

In the northwest quadrant land use is primarily residential near I-5. John Stanford International School is located near the bridge along 5th Avenue NE. Farther south, land use changes to primarily commercial and industrial, and parklands and trails along most of the waterfront. In the northeast quadrant land use is primarily residential near I-5 and changes to commercial and industrial down to the waterfront.

The City of Seattle property line noise regulations are outlined in SMC 25.08.410 of the municipal code. The maximum permissible noise levels depend on the land uses of both the source noise and receiving property (Table 2). The environmental designation for noise abatement (EDNA) is defined by the land use of a property. In general, residential uses are class A, commercial are class B, and industrial are class C.

Table 2: Maximum Permissible Environmental Noise Levels

EDNA OF NOISE SOURCE	EDNA OF RECEIVING PROPERTY		
	Residential (dBA)	Commercial (dBA)	Industrial (dBA)
Rural	52	55	57
Residential	55	57	60
Commercial	57	60	65
Industrial	60	65	70

Source: Seattle Municipal Code SMC 25.08.410

Noise from traffic operating on public roadways is exempt from SMC 25.08.410. Construction noise is exempt from property line standards during daytime hours. Nighttime construction noise from the project, however, must meet City of Seattle property line regulations. Noise levels in Table 7 apply to construction equipment only at rural and residential receiving properties between 10 p.m. and 7 a.m.

Construction Noise

Construction of any of the noise walls will require nighttime construction activities. Therefore, a nighttime noise variance will be required from the City of Seattle. Construction noise mitigation requirements will be developed in coordination with the City and specified in the noise variance. To reduce construction noise at nearby receptors, mitigation measures such as the following could be incorporated into construction plans, contractor specifications, and variance requirements:

- Develop a construction monitoring and management plan that establishes specified noise levels that may not be exceeded by the contractor during specific time periods.
- Construct temporary noise barriers or curtains around stationary equipment and long-term work areas located close to residences.
- Limit the noisiest construction activities to before 10:00 PM on weekdays and weekends reducing construction noise levels during sensitive nighttime hours.
- Equip construction equipment engines with adequate mufflers, intake silencers and engine enclosures.
- Use the quietest equipment available.
- Require the use of OSHA approved ambient sound level backup alarms.
- Turn off construction equipment during prolonged periods of non-use.
- Maintain all equipment and train operators in their proper use.
- Where possible, locate stationary equipment away from sensitive receiving properties
- Provide a 24-hour noise complaint line.
- Notify nearby residents prior to periods of intense nighttime construction

APPENDIX C: Calibration and Validation of Noise Model

Calibration of Model

FHWA has determined that the TNM v. 2.5 model tends to over or underpredict sound levels an average of 0.5 dB. Therefore, field noise measurements were made under controlled conditions (e.g., known distance from roadway source, radar measured speed of traffic, exact count of vehicles, measurement of atmospheric conditions). These field variables were entered into a simple TNM calibration model and compared with the predicted values modeled under the same conditions. The difference between the measured and modeled values in this model is known as an adjustment factor. This adjustment factor is used to calibrate or "zero out" the models tendency to over or underpredict. The adjustment factor is also used in all subsequent TNM models to ensure noise predictions are as accurate as possible.

Validation of Model

Two separate validation models were built to represent the existing direct path and reflected path conditions in the project area (see direct path and reflected path methods below). Noise levels were measured in the field at four locations in the SW Quadrant, four locations in the SE quadrant (Figure 4), two locations in the NE quadrant, and one location in the NW quadrant (Figure 5). Fifteen-minute time-weighted noise measurements were taken at each location during one or more periods of the day (Table 3). Measured noise levels were compared to modeled noise levels at the same locations. If the difference between measured and modeled sound levels were within ± 2 dBA the model is considered valid (Table 4). Traffic noise from the I-5 mainline and express lanes was the dominant noise source in the project area.

Table 3: Noise Measurement Results

Site	Location	Date	Leq (dBA)
M-1	2731 Boylston Avenue E.	7/22/04	71.4
M-2	2728 Harvard Avenue E. (at Hamlin)	7/26/04	77.0
M-4	Harvard Between E. Shelby and E. Gwinn	7/26/04	76.2
M-5	Franklin Avenue E. (dead-end at traffic circle)	7/22/04	83.9
M-7	Harvard Avenue E. at E. Gwinn	7/26/04	79.0
M-8	E. Allison Between Eastlake Avenue E. and Harvard Avenue E. (west of I-5).	7/22/04	80.2
M-12	South Passage Point Park (Fuhrman Avenue E.)	7/22/04	75.8
M-14	3918 Pasadena Pl. N.E. (WSDOT Maintenance Building)	7/28/04	76.4
M-16	N.E. 40th and 5th Avenue N.E. (behind homes in storage area under I-5)	7/28/04	78.8
M-18	Pasadena Pl. N.E. and N.E. 42nd Avenue (intersection north of 42nd off ramp)	7/27/04	79.7
M-19	3245 Eastlake Avenue E. (in rear of units)	7/27/04	80.1

Each measured receptor site is described below:

M-1. Located on residential property at 2731 Boylston Ave. E on the west side of Boylston Avenue E., just south of E. Hamlin. Noise levels at this site are typical of those experienced by residences in the area. Typical noises were primarily from I-5 mainline.

M-2. Located on residential property at 2728 Harvard Avenue E. on the east side of Harvard Avenue E. just south of E. Hamlin, near a residence. Noise levels at this site are typical of those experienced by residences along Harvard Avenue E. in this immediate area. Noise sources were predominantly from automobiles traveling on I-5 mainline.

M-4. Located on residential property three feet east of the edge of northbound lanes of Harvard Avenue E between E. Shelby and E. Gwinn. Noise levels at this site are typical of those experienced by four residences. Noise sources were from automobiles primarily on I-5 mainline and secondarily on the express lanes.

M-5. Located on residential property two feet from the west edge of the cul-de-sac end Franklin Avenue E. Noise levels at this site are typical of those experienced by 12 residences. Noise sources were from automobiles primarily on the express lanes.

M-7. Located on the parking strip in front of a residential property two feet from the east edge of Harvard. Noise levels at this site are typical of those experienced by one residence. The dominant noise source was from automobiles on the I-5 mainline and the express lanes.

M-8. Located in the open area on the northeast corner of E. Allison and Eastlake Avenue E. approximately 50 feet from the corner. Noise levels at this site are typical of those experienced by mostly commercial businesses in the area. Noise sources were from express lane traffic noise reflected from the bottom of the mainline.

M-12. Located at the northern end of South Passage Point Park (Fuhrman Avenue E.) approximately five feet from the waters edge under the high power lines. Noise levels at this site are typical of those experienced by park users and the Pocock Rowing Center. The dominant noise source was from traffic noise reflecting off the bottom of the mainline.

M-14. Located immediately east of the WSDOT Maintenance building fenced lot at the southeast corner. Noise levels at this site are typical of those experienced by commercial businesses in the area. The dominant noise source was from traffic noise reflecting off the bottom of the mainline.

M-16. Located 25 feet east of back fence of residence near the WSDOT storage area under the bridge on the corner of NE 40th and 5th Avenue. Noise levels at this site are typical of those experienced by four residences. The dominant noise source was from traffic noise reflecting off the bottom of the mainline.

M-18. Located five feet from the corner of Pasadena Pl., NE and NE 42nd Avenue. Noise levels at this site are typical of those experienced by six residences. The dominant noise source was from traffic noise reflecting off the bottom of the mainline.

M-19. Located 50 feet west of the condominiums at 3245 Eastlake Avenue E. in the parking lot. Noise levels at this site are typical of those experienced by 10 residences. The dominant noise source was from traffic noise reflecting off the bottom of the mainline.

Figure 2: Sound Level Measurement Locations South

Figure 3: Sound Level Measurement Locations North

Table 4: Traffic Model Validation Comparison

Site	Measured Levels Leq (dBA)	Modeled Direct Path Levels Leq (dBA)	Modeled Reflected Path Levels Leq (dBA)	Combined Direct + Reflected (dBA)	Difference[1] (Measured – Combined) (dBA)
M-1	71.4	72.7	N/A	72.7	1.3
M-2	77.0	76.4	N/A	76.4	-0.60
M-4	76.2	75.7	74.5	78.2	1.95
M-5	83.9	80.1	80.3	83.2	-0.69
M-7	79.0	76.2	77.4	79.9	0.85
M-8	80.2	73.1	78.4	79.5	-0.68
M-12	75.8	65.2	77.5	77.7	1.95
M-14	76.4	66.1	77.5	77.8	1.40
M-16	78.8	74.2	77.2	79.0	0.16
M-18	79.7	75.4	74.5	78.0	-1.72
M-19	80.1	68.2	79.3	79.6	-0.48

N/A – Not applicable, no reflected noise at this location
[1] – Difference must be ± 2 dBA for the model to be valid.

APPENDIX D: Methodology

Site Information

The Ship Canal Bridge was constructed prior to the development of computer-aided drafting (CAD). Therefore no CAD files for the bridge are currently available. CAD files are used extensively in our traffic noise modeling to accurately define the roadway alignment, elevations, and receiver locations for our models. We were able to obtain CAD files of the study area from the City of Seattle that were created using information retrieved from Light Detection and Ranging (LiDAR) equipment that is generally accurate to within ±0.5 feet vertically and ±two to four feet horizontally. This provided us with an accurate base on which to build our models.

The number of households in the study area was determined by counting mailboxes for each dwelling within the study area. For the modeled noise, these numbers are input into the traffic noise model. For facilities such as parks and schools in the project area the number of users of those facilities are converted to an equivalent number of households. The method for calculating residential equivalency is based on the WSDOT directive D22-22. Residential equivalency calculations can be found in Appendix M.

Field Measurements

Noise measurements were taken in the field in accordance with FHWA guidance (FHWA, 1998). Ono Sokki model LA 4350 noise meters were used to measure 15-minute Leq values. FHWA allows 15-minute measurements or less if the Leq does not change for 5-minutes. Our own side-by-side tests have shown that there is virtually no difference between our 15-minute and 1-hour Leq measurements of traffic noise. All noise meters were calibrated prior to the measurements. Meter calibration varied by less than 0.3 dB during the measurement periods. Complete calibration checks of all noise meters are performed in-house with a U.S. National Institute of Standards and Testing (NIST) calibrated meter on an annual basis. If noise meters are outside the acceptable calibration limits they are sent out for NIST calibration. The systems used for the measurements meet or exceed the requirements for an ANSI Type I noise measurement system.

Traffic Noise Modeling Methods

WSDOT acoustics specialists use a standardized approach when modeling noise levels and noise barrier design. However, due to the complexity of the noise environment around the Ship Canal Bridge, from both direct path and reflected path noise sources, more sophisticated modeling methods were required for this analysis.

Traffic noise levels were calculated using the latest version (v. 2.5) of the FHWA-approved Highway Traffic Noise Model (TNM). The WSDOT traffic office provided peak hour traffic volumes for the years 2004 and 1999 as input for our models.

Modeling of reflective noise walls (e.g., concrete, Paraglass Soundstop©, Quilite®) used the standard TNM wall characteristics in the internal model calculations. For sound-absorbing walls (e.g., Acoustax, Silent Screen, Sound Fighter Systems, Carsonite), sound absorptive information provided by the material manufacturer was used.

Each quadrant of the study area (SW, SE, NE, and NW) was modeled using peak (AM) hour traffic volumes for both the express lanes and I-5 mainline for the years 2004 and 1999 (Table 5). The peak AM traffic volumes were the highest hourly traffic volumes. Speeds used in the model were posted speeds for both the express lanes and I-5 mainline. Percentages of autos, medium trucks, and heavy trucks used assume 90% autos, 3% medium trucks, and 7% heavy trucks (same as original report dated January 2004). The difference in traffic volumes between 1999 and 2004 is approximately 1% which represents a negligible change in sound levels.

Table 5: Traffic Volumes and Speeds Used for Modeling Noise

	Express Lanes		I-5 Mainline			
	Northbound		Northbound		Southbound	
Year	**1999**	**2004**	**1999**	**2004**	**1999**	**2004**
Cars	5,344	5,130	6,056	6,849	7,044	6,669
Medium Trucks	178	171	202	228	235	222
Heavy Trucks	416	399	471	533	548	519
Speed	60	60	60	60	60	60

Direct Modeling Methods

The noise environment in the study area consists of both direct and reflected noise sources. Direct path modeling was performed using standard TNM modeling methods as outlined in FHWA, 1998. Northbound and southbound traffic on the I-5 mainline and the express lanes (southbound only) were modeled in the direct path model. Direct path noise was modeled independently from the reflected path models. Direct path noise levels for the existing (2004) noise conditions and 1999 noise conditions, without noise walls and with noise walls. Direct path noise levels were then summed logarithmically with the reflected path noise levels to determine the total noise level at each modeled receiver.

Reflective Modeling Methods

Noise from the express lane traffic reflects off of the bottom of the upper I-5 mainline deck. However, the most current TNM version is not capable of modeling traffic noise reflected off the bottom of elevated roadways. Therefore a new approach was applied to the reflected path TNM modeling methods. This new method considers the shortest reflected noise path that contains the highest sound energy (Figure 7). The method used is based on a method presented by Reiter and Bowlby (2001). We also assume a 100 percent reflection at the bottom surface of I-5 mainline (i.e., sound energy does not dissipate into the reflection surface) to assume a most conservative approach. Southbound and northbound I-5 mainline roadways along with their traffic are removed from the reflected noise model. Only express lane traffic noise transmits directly to each virtual receiver location.

Projected receivers are created in the reflected path TNM model by simulating a mirror image of the receiver above the express lanes. The height of each projected receiver is calculated in an Excel spreadsheet by measuring the distance from the top elevation of the receiver ($\mathbf{Z_{rec}}$) to the elevation of the bottom surface of the I-5 mainline ($\mathbf{Z_{ref}}$). This distance is then doubled to create a projected image that gives the new top elevation of the projected receiver (Proj $\mathbf{Z_{rec}}$). This new height is then added to the original height of the receiver in the TNM reflected noise model. The formula used to calculate the projected height is given below:

$$\textbf{Proj } \mathbf{Z_{rec} = 2 \ X \ (Z_{ref} - Z_{rec})}$$

Proj Z_{rec} is the height of the projected receiver, **Z_{ref}** is the elevation of the bottom of the I-5 mainline and **Z_{rec}** is the original height of the receiver. Figure 5 shows the schematic drawing of the reflected and the projected noise paths. Receivers with **Proj Z_{rec}** less than five feet (default TNM receiver height) were assumed to experience direct noise only and the original receiver height was not changed.

By assigning a projected height to each receiver location experiencing reflected noise and removing the I-5 mainline roadway from the model, TNM will calculate the simulated reflected noise. Reflected noise levels are then added logarithmically to the direct path noise levels for each receiver to determine the total noise levels.

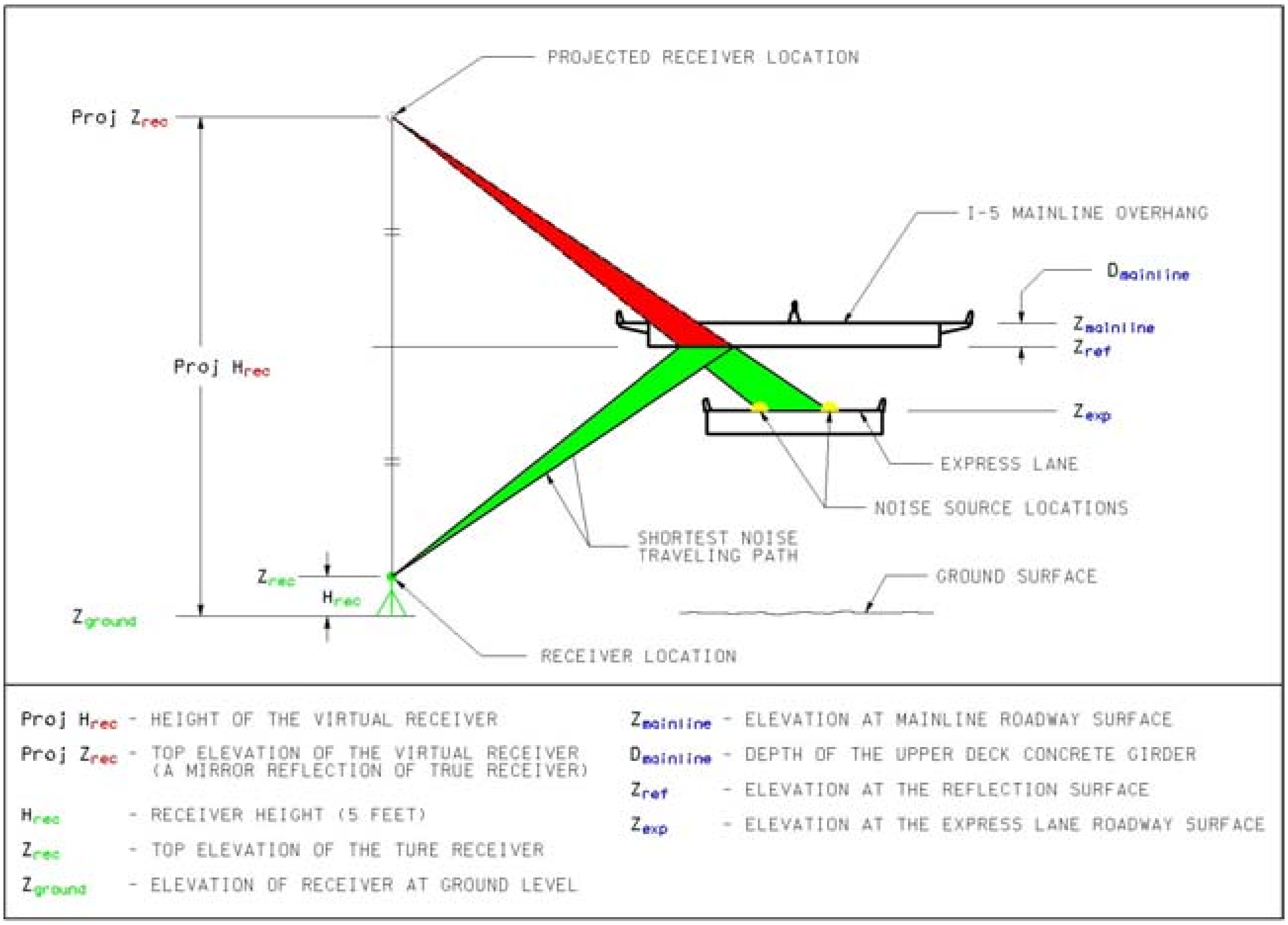


Figure 4: Schematic Drawing of Modeling Reflected Noise

Analysis Year

WSDOT determined noise levels for the year 1999 in this analysis. The 1999 noise levels were used to determine the size and extent of recommended noise walls, and to provide information needed to rank projects on the retrofit list. Currently all retrofit walls are ranked with traffic data from 1999. The 1999 traffic data is used in this analysis to be consistent with current ranking criteria used for other retrofit walls.

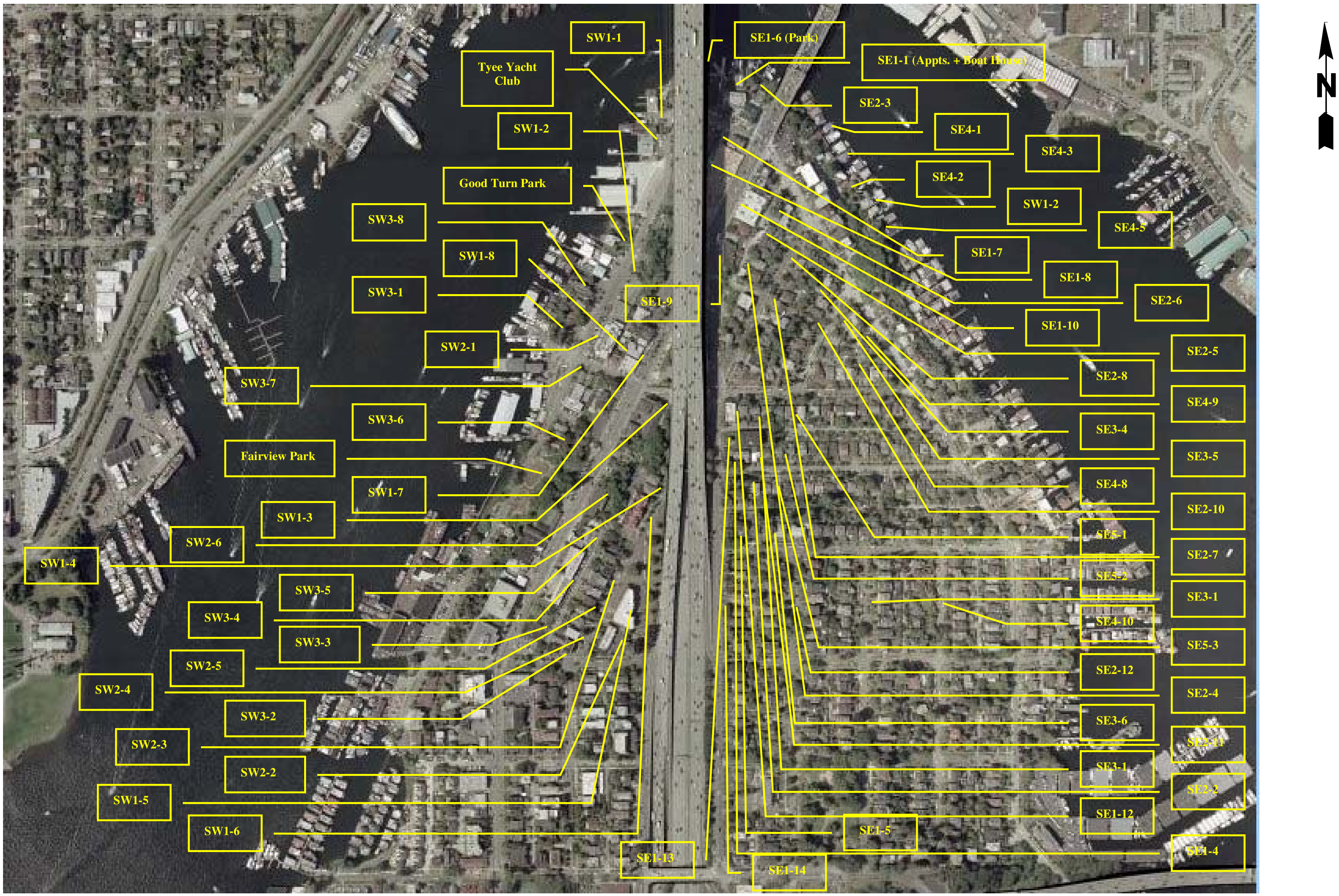


Figure 5: Sound Level Modeling Locations Southern Area

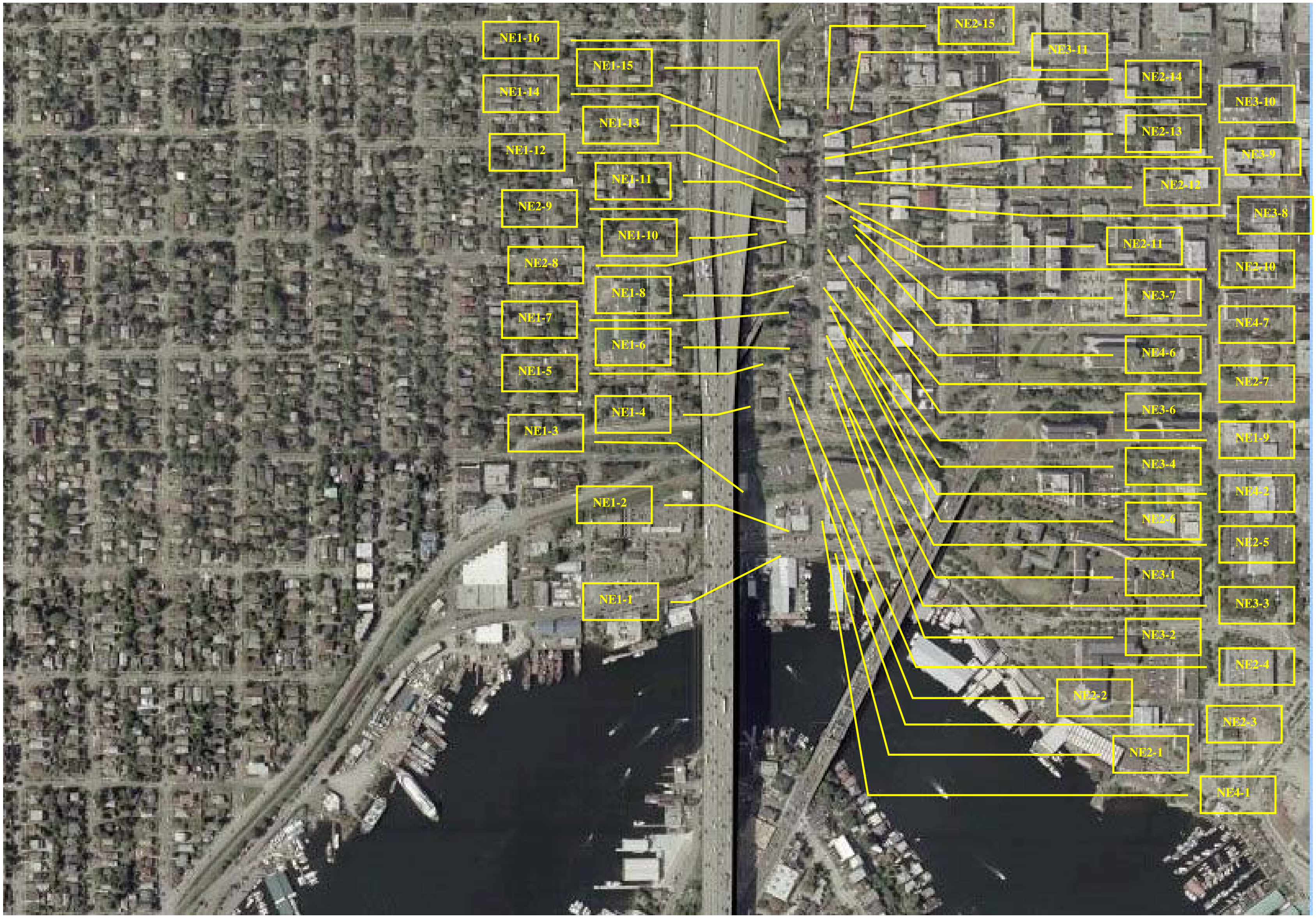


Figure 6: Sound Level Modeling Locations Northeast Quadrant

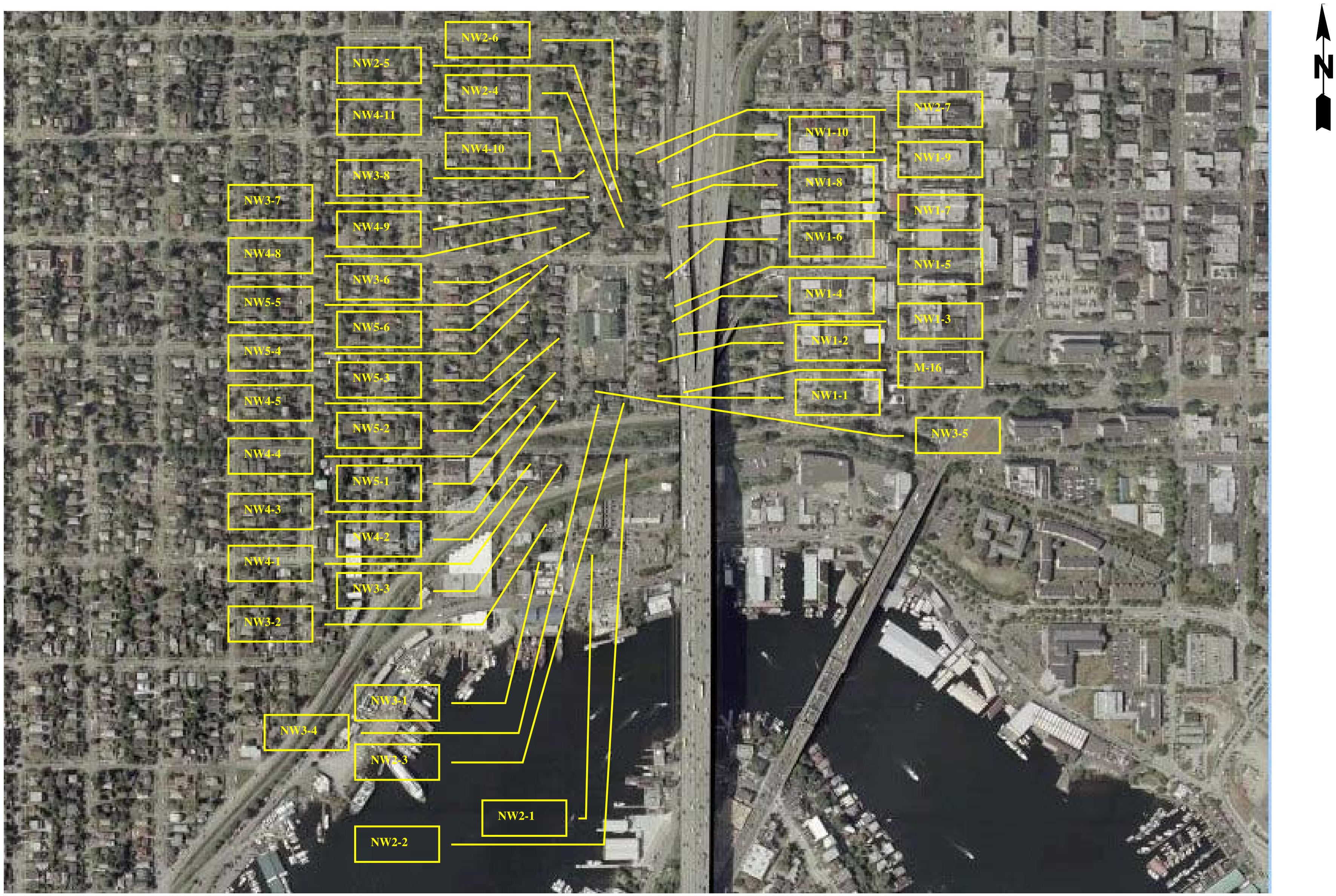


Figure 7: Sound Level Modeling Locations Northwest Quadrant

APPENDIX E: Ship Canal Bridge Structural Analysis

This noise analysis uses information and recommendations from the structural feasibility and cost analysis previously completed by the WSDOT Bridge Office. The Bridge Office produced an update to the original SR 5, No. 570 – Ship Canal Bridge Noise Mitigation Structural Feasibility and Cost Analysis (2003) prior to the current Ship Canal Bridge noise modeling (see Appendix F).

Lightweight Material Recommendations

The Bridge Office evaluated a total of nine lightweight materials (Table 6). Six of these materials were determined to be applicable for use on the Ship Canal Bridge. This report analyzes these six materials.

- Paraglass Soundstop© (reflective);
- Quilite® (reflective);
- Acoustax (absorptive);
- Carsonite (absorptive);
- Sound Fighter® (absorptive) and;
- Silent Screen (absorptive).

Plastic panels were determined to be not applicable because they were originally investigated under a research grant and there are no current manufacturers of this material. Sound Zero from Symetry Group was not considered applicable for use because not enough information is available to review this product. Delta T Industrial Coating was not considered applicable because its use will not allow proper inspection of the bridge structure.

Recommendations for Structural Installation

The Bridge Office determined that the weight of these lightweight noise wall materials is not a concern for the structural stability of the bridge as a whole. However, the locations where the panels are attached to the bridge structure will be subject to heavy wind loads. These locations may need to be rehabilitated to accommodate the noise walls. Rehabilitation will require replacement of the traffic crash barrier and roadway slab. To minimize the amount of structural rehabilitation and cost required for mounting, Option 2 was recommended by the WSDOT Bridge Office for both the steel truss section and the concrete approach sections.

Wall Installation for Steel Truss Bridge Section

Option 2 for the steel truss section provides full-height posts, to share the wind load between the top and bottom superstructures. The posts will be attached to a horizontal brace between two stringers. Attaching the post to the top concrete deck is not desirable because anchors cannot be placed through the deck.

Wall Installation for Concrete Approaches

Option 2 for the concrete approaches provides a steel bracket attached to the side of the concrete box girder. The posts for the noise wall are then attached to the brackets and extend vertically to the required wall height.

Maintenance Considerations

Noise walls on the bridge structure taller than seven feet will have to accommodate the use of an Under Bridge Inspection Truck (UBIT). The recommended solution to providing access to the UBIT is to provide sliding access doors in the noise walls at designated intervals (approximately 40-50 foot intervals). It is not known if this will reduce the effectiveness of the noise walls in these locations.

Installation Alternatives

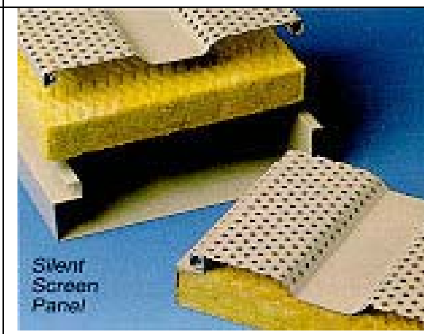
Option 2 also includes alternative approaches for mounting the noise wall material. In the steel truss portion of the bridge, the wall will be mounted on top of the crash barrier. In this scenario, crash testing may be required to identify its response to a vehicle impact. Except for Paraglass Soundstop©, the Barrier Specialist in the WSDOT bridge office is not aware of any crash barriers with attached noise walls that have been tested.

For the concrete approach portion of the bridge, the Bridge Office recommended placing the wall on the outside of the crash barrier. Attaching the noise wall behind the traffic barrier will prevent vehicle impact and damage to the wall, passing motorists, and people or property below the bridge.

Table 6. Lightweight Materials Considered for the Ship Canal Bridge

Name	Manufacturer	Material	Cost	Properties	
Plastic Panels	None	Hollow Plastic	$7/ft^2	Unknown	No Picture Available
Quilite®	Quilite® International	Lexan® Polycarbonate Blocks	$28/ft^2 (NV DOT)	- Translucent but not transparent - Can be used as a reflective wall up to 30 feet high - Wind load length to deflection ration @ 60 mph = deflection 240 - Used CalTrans, NY DOT, and Nevada DOT	
Paraglass Soundstop©	CYRO Industries	Polycarbonate Panels	$70/ft^2 (NJ DOT)	- Soundstop© GS CC incorporates polyamide filaments to hold the broken sheet when impacted by vehicle and provide visibility to avoid bird impacts - Sound reflective noise wall - Seven transparent colors - 10 year warranty against loss of clarity due to weathering - Two Grades: Standard acrylic sheet and GS CC with polyamide filaments - Used by New York, Florida, and Nevada DOTs - Proposed for use by Maryland DOT and Virginia DOT.	

Name	Manufacturer	Material	Cost	Properties	
Acoustax	Faddis Concrete Products	Perforated Aluminum/Steel Panels	$15/ft^2	- Vertical or horizontal absorptive panels - Various perforation patterns - Aliphatic Urethane Polyester graffiti resistant powder coating is available - Used by Ohio DOT - Not used in this application before but can also be suspended from ceilings	
Sound Zero	Symmetry Products Group	Composite material	Unknown	Unknown, company unresponsive	
Composite Panels	Carsonite International	Composite Fiberglass filled with crumb rubber	Unknown	- Exceeds AASHTO and DOT soundwall guidelines for wind loads - Provides positive use of unwanted tire waste - Available in many colors	

Name	Manufacturer	Material	Cost	Properties	
Sound Fighter® LSE System	Sound Fighter® Systems, LLC	HDPE Shell with Mineral Wool	$15/ft^2$	- Absorptive noise wall panels - Used worldwide for over 30 years - Low maintenance - Used at the Washington State University Mariner Hospital.	
DeltaT Industrial Insulating Coating	Mascoat Products	Paint Additive with Ceramic Spheres	Unknown	- Absorptive paint with small ceramic balls - Rapid application and low maintenance costs - Allows for surface inspectability at all times	NO PICTURE AVAILABLE
Silent Screen, Absorptive Panels	Empire Acoustical Systems	Perforated Steel /Aluminum with or w/o Mineral Wool	$15/ft^2$	- Absorptive panels can be used as a lightweight noise wall - Silent Screen can be suspended from ceilings	

SR 5, NO. 570 – Ship Canal Bridge Noise Mitigation Structural Feasibility And Cost Analysis Supplemental Report

Prepared for:
Washington State Department of Transportation
Air, Noise and Energy Program
15700 Dayton Avenue North, NB82-138
P.O. Box 330310
Seattle, WA 98133-9710

Prepared by:
Geoff Swett, P.E., S.E.
WSDOT – Bridge and Structures Office
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S1. Introduction

S1.1 Purpose

The *Noise Mitigation Structural Feasibility and Cost Analysis Report* for the SR 5, No. 570 – Ship Canal Bridge completed in 2003 was developed considering only one type of noise mitigation barrier. The specific barrier type was the Noiseshield Type FS absorptive barrier manufactured by Industrial Acoustics Company. The barrier was analyzed as being used as a conventional noise wall and as an absorptive barrier, which was to be suspended from the bottom of the upper roadway decking. The purpose of this supplemental report is to analyze additional noise mitigation products that are currently available on the market to determine their feasibility and cost for use on the Ship Canal Bridge.

The Washington State Department of Transportation (WSDOT), Air, Noise and Energy Office performed a literature search on alternative and emerging products to be considered for use on the bridge. The search identified nine alternative noise abatement materials. Of the nine alternatives, eight are noise panel/wall type products and one is a paint additive, which is applied to the structure surface. Each of these products will be reviewed and analyzed. The analysis will consist of advantages, disadvantages, direct material and installation costs, and associated structural rehabilitation costs, if necessary. Since the initial study was based on the Noiseshield Type FS barrier, comparisons will be made between the alternative noise mitigation measures and the Noiseshield barrier. One of the significant advantages of the Noiseshield system is that it can be used as a vertical noise wall on the side of the bridge and can also be suspended from the top roadway deck to provide absorption of noise. Reflected noise off the bottom of the top deck was found to contribute to the overall noise levels experienced by the adjacent residents. Using the same material for both applications helps keep overall costs down by the increase in overall quantity. The larger the quantity, the lower the cost.

S1.2 General Discussion

As discussed in the initial report there are a number of constraints, which need to be considered when evaluating the addition of noise mitigation measures to the bridge. Specifically, WSDOT Maintenance and the Bridge Preservation Office must have access off the side of the bridge with the Under Bridge Inspection Truck (UBIT), spray on materials that preclude inspection of the bridge must be avoided, and all additional loads applied to the structure as a result of the addition of noise mitigation measures must be rectified.

The additional wind loading on the structure is the primary concern. The noise barriers, when added to the structure, create a large sail effect for which the structure was not designed. The wind loading was the reason for the costly structural rehabilitation identified in the initial report. All of the eight alternative wall type noise mitigation products will have similar wind loading issues that will need to be addressed. Various options for supporting the Noiseshield Type FS barrier were presented in the initial report to try and reduce the rehabilitation costs. One item that will need to be analyzed in this report is whether these support options can be used or slightly modified to accommodate the alternative wall panel types.

The additional weight from adding noise mitigation measures was found in the initial report to be of little consequence. The seismic upgrade of the structure performed in the 1990's provided sufficient capacity to handle the additional weight on the structure. It is assumed that weight for the alternative wall types will be of little consequence also.

A review of the nine alternative mitigation products by the WSDOT Bridge Architect will also be presented. Since the Ship Canal Bridge is a monumental, highly visible structure in Seattle, aesthetics will need to be considered and incorporated into any final design.

S2. Analysis

S2.1 Alternative Product #1: CYRO Industries – Paraglass Soundstop®

Paraglass Soundstop is a transparent sheet used as a noise barrier material along roads and railroads. There are two types of sheet available, a standard clear transparent sheet – Paraglass Soundstop, and a transparent sheet that incorporates embedded polyamide filaments to hold a broken sheet together in the event of an impact – Paraglass Soundstop GS CC. The second sheet type will be required for this application. The sheets can be obtained in various thicknesses ranging from 15 mm (.59") to 25 mm (.984"). The thicker the sheet the more sound reduction and the longer the sheet can span between supports.

The weight of the material is lighter than the Noiseshield Type FS previously analyzed, (7.5 #/SF versus 6.1 #/SF for the 25 mm thick sheet) therefore weight will not be an issue. The sheets are installed in a similar method as the Noiseshield panels in that they are supported between vertical I-section posts. The support options described in the initial report for installing the Noiseshield barrier are applicable for Paraglass Soundstop sheets. The cost differences will then depend primarily on initial purchase costs, installation costs, and long-term maintenance.

From a review of the product literature, there has been extensive testing on the flammability characteristics and the impact resistance. The Paraglass sheet appears to be resistant to both fire and projectile impacts.

Following are some advantages and disadvantages with using this product.

Advantages:

1. The transparent sheet will retain the view for the motoring public. (Lake Washington, Lake Union, University of Washington, etc.)
2. There will be no need for under deck lighting, which may be required if a solid wall system is utilized.
3. Graffiti can be washed off versus having to re-paint or re-finish a solid panel type.

Disadvantages:

1. Cost – the initial material costs are greater than alternative non-transparent wall types. However part of the initial cost may be offset by the fact that under deck lighting will not be required.

2. Cleaning – the transparent sheets may need to be cleaned on a regular basis. The manufacture claims the sheet is "self-cleaning", however these sheets will be below the upper deck of the Ship Canal Bridge and will not be exposed to regular rainfall. Cleaning of the transparent sheets was discussed with the Northwest Region Bridge Maintenance Office. The Bridge Maintenance crews have not performed any bridge washing in the last 10-12 years. The primary reasons are the environmental restrictions and the costs. They have recently obtained a Hydraulic Permit Approval (HPA) for bridge washing. However, the permit requires that washing is done often enough that no or minimal solids are washed from the bridge. Solids will include any dirt or soot build-up, bird guano, waste debris etc., which will all have to be removed by hand prior to washing the bridge. Removal of solids prior to washing will be an enormous and expensive task, particularly since it has not been done in recent years. The restrictions imposed by the HPA limit its practical use. The maintenance schedule and method of cleaning the Paraglass sheets will need to be resolved before its use in a project.
3. These panels are not absorptive and will not be applicable as horizontal panels on the bottom of the upper deck. An alternative product will need to be used such as the Noiseshield Type FS barrier.
4. There is potential for glare from headlights reflecting off of the sheets. The potential is small because of the tangent roadway alignment and one-way traffic on the express lanes.
5. The product literature claims the Paraglass is UV resistant, however there is the potential for yellowing of the sheets over time. Replacement of the sheets may eventually be required.
6. There is a potential for birds flying into the glass. Colors or designs can be added to the sheets to reduce this potential hazard.
7. The impact of a vehicle on the barrier/noise wall constructed of the Paraglass sheets will need further investigation. The literature discusses impact resistance, however it is directed more towards a rock or other projectile. In discussions with the manufacturer, they have developed another system that is intended to resist vehicle impact. They will be running crash testing in August 2004 in accordance with NCHRP-350 Test Level 4 (TL4). Test Level 4 is the level at which all WSDOT highway barrier is tested to.

Note: Vehicle impact on any of the noise mitigation systems will be a concern, and therefore not limited to just this product. If noise mitigation products are placed on the barrier, crash testing of the system may be necessary. Some of the options for supporting the noise barrier presented in the initial report are behind the barrier, which will greatly reduce the risk of damage by vehicle impact.

Following is a breakdown of costs for this product assuming the same quantity as was used for the Noiseshield barrier in the initial report. The Noiseshield barrier will be assumed for the horizontal ceiling panels. The costs will be based on Option 2 presented in the initial report for both the concrete and steel truss spans. Refer to Figure 11 and Figure 17 in the initial report for an illustration of Option 2 for the concrete and steel spans, respectively. In the cost information for the Noiseshield barrier, a cost of $20/SF was added to the material cost for installation, support beams, profit etc. Therefore, the same method will be used for cost information of the alternative noise mitigation methods, unless additional costs are identified. A cost of $70/SF will be used for the Paraglass Soundstop product.

S2.2 Alternative Product #2: Quilite® – Lexan Polycarbonate Blocks

The Quilite product consists of hollow 16” square polycarbonate modules, which are assembled together to form a wall panel. The modules are supported by steel frames that can vary in size and strength to accommodate various support spacing and wind loads. The blocks are translucent but not transparent. The blocks are 5” thick and weigh approximately 6#/SF. Again, weight will not be a concern for this wall type and the primary loading concern will be wind. The blocks, when assembled into a panel, are supported between vertical posts. Therefore the support options previously developed should be applicable to this wall system.

Following are some advantages and disadvantages with using this product.

<u>Advantages:</u>

1. The translucent blocks will allow light through the wall, thus eliminating the need for under deck lighting on the bridge, however it is uncertain how much view will be retained for the traveling public. The actual modules can be slightly modified to provide a more transparent visual image.
2. May not require the amount of cleaning that will be necessary with the Paraglass sheets because it is translucent and not transparent. Soot and debris on the modules will be less noticeable.
3. Provides flexibility in the size of wall panels because of the small units.
4. Less likely for birds to fly into the wall.

<u>Disadvantages:</u>

1. Cleaning – the Quilite product will require cleaning, although it will probably less frequent than the Paraglass system. (See above in the Paraglass section for more info on disadvantages with cleaning)
2. It is unclear on how the wall will perform with a vehicle impact and what safety features could be added to the wall system to protect motorist and people/property below the bridge in the event of a vehicle impact. The manufacturer stated that a positive connection to the support post could be added to the panels to protect the unit from falling in the event of a vehicle impact.
3. It is not designed as an absorptive type material and could not be used as a horizontal panel suspended from the upper deck. The manufacturer stated that the modules have been shown in field tests to diffuse sound waves, but not absorb.
4. There is potential for glare from headlights reflecting off of the sheets. The potential is small because of the tangent roadway alignment and one-way traffic on the express lanes.

Following is a breakdown of costs. A cost of #30/SF will be used for the Quilite panels. This is the same cost as was used for the Noiseshield. The Noiseshield panels will be assumed for the ceiling panels.

S2.3 Alternative Product #3, #4, & #5:

#3. Faddis – Acoustax
#4. Sound Fighter® Systems, LLC – Sound Fighter LSE System
#5. Empire Acoustical Systems – Silent Screen Reflective Panels

All of the three products listed above are similar to the Noiseshield Type FS barrier system in that they can be used as vertical noise barrier walls and have absorptive qualities and therefore can be suspended from the upper deck as a ceiling panel. All the systems are supported by vertical posts and are stacked on top of each other to achieve the desired wall height. All three systems have similar costs and installation methods. Each system has its own architectural features or enhancements that can be incorporated into the panel. Because of the high visibility of the structure, the aesthetics of the wall will play a significant roll in the final wall choice.

The advantages and disadvantages will not be outlined in detail since these systems are similar to the Noiseshield system. The primary differences or disadvantages between the three listed products and the Noiseshield system will be the maximum length between support beams. The initial report described three support options for the concrete spans of the bridge and 2 support options for the steel truss spans of the bridge. Option 2 and 3 of the concrete spans and option 2 of the steel spans rely on the support spacing being a minimum of 12'to 18' for the options to be cost effective. The Faddis Acoustax system can span up to approximately nine feet. The Sound Fighter system is designed to span approximately six feet. The Empire system can span up to 14 feet (14' is their manufacturing size limit). The 9' and 14' spacing of supports will still be cost effective, however the 6' spacing does not seem like a good choice for this application. Because of the size and length of this structure, using 6' spacing will require many posts and will not be aesthetically pleasing. (See additional comments from the Bridge and Structures Architect in Section S2.7) The 6' spacing will also preclude the use of option 2 for the steel truss spans. Option 1 for the steel span requires more structural rehabilitation of the bridge (~ $2 million additional rehab). The 6' max spacing will also make it difficult if not impossible to incorporate maintenance doors in the walls greater than 7' in height.

The cost for these systems is approximately $35/SF installed and will be used for the noise barrier and ceiling panels. The breakdown below is applicable for the Faddis and Empire systems. The Sound Fighter system will be considered eliminated as a choice.

S2.4 Alternative Product #6: Carsonite International – Carsonite Composite Panels

This product is similar to the Noiseshield product in that it consists of panels that are supported by vertical beams. It doesn't have the absorptive properties of Noiseshield so the Noiseshield panels will be assumed for the ceiling panels. The panels are made from fiberglass-reinforced polymer composite that can be supplied hollow or filled with recycled tire waste. The use of the recycled tire waste is the purchaser's choice and usually depends on the local availability of scrap tires. The panels can span the distances required to use the support option 2 for the concrete and truss spans. The panels weigh approximately 7.5 #/SF, similar to the Noiseshield system, therefore weight will not be concern.

Some advantages and disadvantages are described below:

Advantages:

1. Light weight and easy to handle for assembling the wall. Panels are 6" wide and are staked on top of each other with a tongue and groove type method.
2. Environmentally friendly in that it provides a positive use for unwanted sources of scrap rubber tires.

3. Fire resistant and does not corrode.

Disadvantages:

1. These panels are not absorptive and will not be applicable as horizontal panels on the bottom of the upper deck. An alternative product will need to be used such as the Noiseshield Type FS barrier.
2. Additional cables or other safety features will need to be added to protect projecting panels under a vehicle impact. See additional comments in section S2.1.
3. Blocks view for traveling public.
4. May require under deck lighting due to the tunnel effect of walls on both sides of the upper deck.

Following is a breakdown of costs. A cost of $30/SF will be used for the Carsonite panels and for the Noiseshield panels to be suspended from the upper deck.

S2.5 Alternative Product #7: Mascoat Products – Delta T Industrial Insulating Coating

This product is primarily used as a thermal insulating coating. It is applied similar to paint and must be applied to a primed surface when applied to carbon steel. Its main purpose is to reflect heat while providing corrosion protection. The technical representative claims a 1-3 dB reduction at 45 dB and the technical literature estimates a five dB reduction at 60 dB.

The Bridge and Structures Office is not in favor of using this material on the steel structure. The literature states that the material allows for substrate inspection at all times, however it is not clear what effect the material will have on identifying cracks etc in the steel. This material is applied in greater thickness than paint. It is not clear whether this material is compatible with our paint systems or what will need to take place prior to a re-painting effort on the structure. Repainting will cover the Mascoat product, which will then need to be re-applied.

This material may be applicable if it could be applied to the bottom surface of the concrete upper roadway. The surface will need to be cleaned and prepped prior to the application, which will require containment and extensive work over the roadway.

This material will need further testing to verify its noise absorptive qualities. It was not designed for this purpose and there is limited information on its true effectiveness in this application.

The Bridge Office recommends this product be dropped as a potential noise mitigation candidate.

S2.6 Alternative Product # 8 & 9:
#8. Plastic Panels – unknown manufacturer
#9. Symmetry Products Group – Sound Zero

There is limited information on these products at this time. Both appear to be panels, which are supported by vertical posts. Plastic panels are a product similar to the Carsonite panels and Sound Zero is a lightweight composite material. The advantages and disadvantages of these products will be similar to the previous discussions. The maximum length of panel will need to be identified before considering as an alternative to take into the design phase.

S2.7 WSDOT Bridge and Structures Review and Comment on the Alternative Noise Mitigation Products.

General Comments: (Paul Kinderman, PE)

The following comments are based on bridge architectural issues.

Note that there is potential for using several of the manufacturer's materials for the final wall design.

Quilite International: Good possibilities for architectural treatment. For example: window frames may lend themselves to 'context sensitive' historic residential neighborhood design motifs or postmodern building facade treatments. Steel frames can be painted to compliment existing steel truss colors and adjacent landscape.

Panels should be used in conjunction with other materials to avoid a monotonous appearance. For instance, a series of 'upper windows' could be detailed with a lower wall of solid panels. The upper windows will admit light, yet be out of the vehicle 'spray zone' requiring less maintenance.

CYRO Industries – Paraglass Soundstop: Good possibilities for architectural treatment. See comments for Quilite International.

Faddis Concrete Products: Fair possibilities for architectural treatment. However, the 'typical post and panel' basic design is not desirable for the monumental bridge and adjacent historic neighborhood setting. Designs may be investigated where this material is used with clear or translucent panels to create interesting facades.

Symmetry Products Group: No comment. Material unavailable for review.

Carsonite International: Fair possibilities for architectural treatment. See comments for Faddis Concrete Products.

Sound Fighter Systems: Fair possibilities for architectural treatment. However, due to the scale of the bridge, the maximum 6' post spacing is the least desirable of all the alternatives.

Mascoat Products: Poor potential for architectural treatment. More appropriate for Industrial applications than a monumental bridge in a historic neighborhood setting.

Empire Acoustical Systems: Fair possibilities for architectural treatment. See comments for Faddis Concrete Products.

S3. Summary

In summary, it appears that several of the alternatives analyzed will be applicable for use on the Ship Canal Bridge. These products could be used in conjunction with one another to achieve the most economical, aesthetic and efficient noise reduction solution. The primary design challenge will be to minimize the amount of structural rehabilitation required due to the large wind loads produced when adding the noise barriers. Weight of the noise barriers is not a big concern and allows the choice of several products.

Total preliminary costs for the materials evaluated range between $9 and $12 million. The preliminary costs are for Option 2 support method only. These preliminary costs do not include sales tax, engineering, contingencies, inflation, and Region items.

During the actual design phase, each applicable alternative will need further review and investigation to identify any possible flaws for this bridge application. The actual quantity of material and cost will also need refinement. The best approach is to design a custom support system that will minimize the amount of structural rehabilitation, but could be used by several of the noise barrier manufacturers. This approach will allow several competitive bidders.

As mentioned earlier, if the wall is mounted directly on or above the barrier, some crash testing may be required to verify its behavior during a vehicle impact. To this date, the Barrier Specialist in our office is not aware of any barriers, with attached noise walls, that have been tested. Paraglass Soundstop will be performing crash testing the summer of 04'. Attaching the noise barrier so it is behind the traffic barrier will be a good solution for avoiding the potential of vehicle impact and damage to the wall, passing motorist, and any people or property below the bridge.

During discussions with Bridge Maintenance, it was discovered that the Ship Canal Bridge has been identified for possible funding by the Department of Homeland Security.

APPENDIX F: Alternative Pavements

Quieter Pavement

WSDOT acoustics has been asked by several citizens to consider using alternative pavements that can provide noise reduction on the Ship Canal Bridge. According to FHWA, different pavement types cannot be considered as an alternative to conventional noise mitigation (i.e., noise walls). However interest by various DOTs and the public in alternative pavements has increased research into this topic. As a result of this interest, potential noise reduction, costs, life cycle considerations, and bridge installation issues for asphalt pavement compared with the current concrete bridge deck surfacing is discussed below.

Asphalt

Knowledge of the rubberized asphalt (RA) piloted in Arizona and the open graded asphalt pavement (open graded friction course or OGCF) under study in California has increased citizen inquires to WSDOT for use of these products. Most of the inquiries come from urban areas along I-5, I-90, I-405, and SR 520.

At this time both open graded and rubberized asphalt is not considered by WSDOT or Federal Highway Administration as a viable answer to noise mitigation when compared to noise walls, berms or the creation of buffer zones. Both rubberized and open graded asphalt pavements have been shown to be more costly (on a life cycle basis) and less durable than traditional dense graded hot-mix asphalt (HMA) pavements or Portland Cement Concrete (PCC) pavements. Open graded and rubberized asphalt mixes may have some measurable improvements for noise reductions from the tire/roadway interface but they do nothing to mitigate for engine and exhaust noise especially from trucks.

Although current studies in Arizona and California show short-term audible and measurable noise reductions, those reductions are not sufficient to meet Washington's minimum noise reduction criteria of 7 decibels and will therefore be considered infeasible on its own. The WSDOT goal is to get 10-decibel reduction from a wall or berm. Both Arizona and California continue to study the more long-term noise improvements due to change in asphalt surface choices.

Climate and the existence of traction sanding and the allowance of studded tires in the Pacific Northwest provides for a very different environment than California and Arizona. Only select areas of Washington have the warm temperatures for application of the rubberized asphalts. Arizona requires that for Asphalt-Rubber Friction Courses, the pavement temperature on the ground be above 75 degrees Fahrenheit which only allows placement during certain months when these temperatures are expected to be obtained. In urban western Washington, to avoid severe roadway congestion, most paving is conducted at night when pavement temperatures rarely exceed 75 degrees Fahrenheit.

In winter with icy conditions, traction sanding fills in the voids of the open graded asphalt, effectively eliminating noise benefits within a few years (Goodwin, Miner 2004). Studded tires rapidly grind the surface of open graded asphalts, shortening the pavement life much more than if standard mixes of dense graded asphalt or Portland cement concrete are used. On a life cycle cost basis (the total cost over a normalized period of measurement) the expected cost of both open graded and rubberized asphalt is much higher than the standard dense graded hot-mix asphalt.

Concrete

Donavan and Scofield (2003) studied different types of surface texturing of Concrete or Portland Cement Concrete pavements (PCC) in Arizona. Concrete pavements can be textured shortly after they are poured with small grooves or can be grooved afterwards with a diamond grinder. They found that instead of using the typical transverse grooving (tining) of the surface that longitudinal tining produced about 5-7 dB lower noise levels for a single vehicle passby. Similar to asphalt pavements, the tining or grooving has a limited lifespan until studded tires and the sheer number of regular tires on I-5 wears away the surfacing. As a single mitigation measure concrete tining or grooving may only reach the minimum noise reductions in certain locations. Further pavement evaluations in Washington State are needed to determine potential noise improvements as a result of concrete resurfacing.

An overlay on the bridge deck was already placed recently, which leaves a diminished capacity for placement of additional pavement without removing the existing layer.

Given the current requirement in RCW 47.05.051(1)(a)(i) and (iii) that the department must use the most cost effective pavements with minimized life cycle cost, it currently appears infeasible to consider open graded asphalt materials on the express lanes of the Ship Canal Bridge. Additional information and research into the wear of concrete surface treatments and rubberized asphalt in Washington State is needed.

WSDOT is currently preparing a white paper researching quieter pavements that should be finalized within the next 6-10 months. Preliminary information indicates that these pavements will not be suited to high traffic volumes on I-5 and studded tires.

SR 5, NO. 570 - SHIP CANAL BRIDGE NOISE MITIGATION STRUCTURAL FEASIBILITY AND COST ANALYSIS

SUPPLEMENTAL REPORT 2

(Hot Mix Asphalt Overlay)

Prepared for:

Washington State Department of Transportation
Air, Noise and Energy Program
15700 Dayton Avenue North, NB82-138
P.O. Box 330310
Seattle, WA 98133-9710

Prepared by:
Geoff Swett, P.E., S.E.
WSDOT – Bridge and Structures Office

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S1. INTRODUCTION

S1.1 Purpose

The purpose of this supplemental report is to analyze the structural feasibility and cost of placing a Hot Mix Asphalt (HMA) overlay on the lower deck of the SR 5 No. 570 Ship Canal Bridge. A HMA overlay is being investigated because of the reduction in wheel-to-roadway generated noise various pavement types exhibit over a typical concrete deck. There are at least four asphalt types available that have been identified for this type of application. These pavements are listed in Table 1 below.

Pavement Type	Approximate Unit Weight	Typical Application Depths
Hot Mix Asphalt – Dense Grade (HMA)	145 pounds/cubic foot	1.8 inches
Rubberized Hot Mix Asphalt – Dense Grade (RA HMA)	145 pounds/cubic foot	1.8 inches
Open Graded Friction Course (OGFC)	125 pounds/cubic foot	.75 inches to 1.5 inches
Rubberized Open Graded Friction Course – (RA OGFC)	125-130 pounds/ cubic foot	.75 inches to 1.5 inches

Table 1.

S1.2 General Discussion

The discussion will begin by stating the WSDOT Bridge and Structures Office does not recommend the use of a Hot Mix Asphalt overlay on the Ship Canal Bridge for the purpose of reducing the amount of road noise. The primary reason for this opinion is that an asphalt overlay will not last as long or provide the necessary protection for the existing concrete deck compared to other concrete overlay options.

Currently, the Ship Canal Bridge has a 6½-inch reinforced concrete deck with a 1½-inch latex modified concrete (LMC) overlay that was added in 1984-85 as a deck protection system. As part of the concrete overlay project, all the expansion joints on the bridge were rehabilitated and raised to accommodate the raised profile.

In order to place an asphalt overlay on the bridge, the existing concrete overlay would need to be removed and replaced with a protective membrane and HMA combination. A HMA overlay with a membrane is considered to be a lower class protective system compared to a modified concrete overlay. This type of deck protective system is generally used on short span bridges and/or bridges with lower traffic volumes. Also, if a HMA overlay was placed on the Ship Canal Bridge it would probably need to be removed and replaced every 4 to 6 years.

S1.3 Asphalt Overlay Discussion

An asphalt overlay by itself does not provide protection against water and deicer intrusion into a concrete bridge deck. A membrane is typically used under an asphalt overlay to provide protection for a concrete bridge deck from corrosive materials like deicers applied in the winter months. There are different types of membranes available such as; a preformed fabric, a liquid asphalt and various types of epoxy and methyl methacrylate polymers.

It is desirable to have a smooth surface for the fabric or liquid asphalt membrane to function properly. Equipment used to remove an existing concrete overlay will leave a rough surface. Therefore, based on past WSDOT experience, the polymer overlay would be the best membrane option for this application. See Figure 1 for a photo of a polymer overlay being placed and Figure 2 for the completed HMA overlay. The combination of a thin polymer/HMA overlay has been used in the past by WSDOT, but is not nearly as good of a deck protective system as a rigid concrete overlay and is not a typical WSDOT practice.

Figure 1: Placing Thin Epoxy Polymer Overlay on Scarified Deck

Figure 2: Completed HMA/Polymer Overlay

There are several additional items that would need to be addressed as part of a new deck overlay project such as; repair of the existing deck and modifications to the expansion joints. A substantial amount of deck repair is anticipated if the existing concrete overlay is removed. Deck repair work is typically paid by a force account bid item so a reasonable cost, based on deck square footage and past experience, will be included in the cost information. The expansion joints will also need to be addressed. Some currently need to be repaired or replaced, and many will need some type of modification to accommodate the HMA overlay. For instance, some of the deck joints will need new concrete headers installed in order to reduce the bump effect at the joint, which occurs due to pounding deformations from vehicle traffic. An example of a deteriorating expansion joint is shown in Figure 3.

Figure 3 – Deteriorating Expansion Joint

As an alternative, one might consider adding the HMA overlay on top of the existing concrete overlay. This approach is not desirable or practical. The primary reason is the added dead load and subsequent reduction in load rating or live load capacity of the bridge

S1.4 Load Rating and the Affects of Placing an Additional HMA Overlay

Each bridge in Washington State is load rated. The load rating checks the capacity of the bridge for several legal vehicle/truck loadings and for various permit required overload vehicles/trucks. The minimum acceptable load rating value is 1.0 for legal loads. The current load rating for the Ship Canal Bridge ranges between 0.97 and 1.09 for legal loads and 0.49 to 1.07 for permit overloads. The WSDOT Bridge Preservation Engineer has the option of restricting legal loads when the load rating reaches 0.9 or lower. Running a full load rating analysis is beyond the scope of this feasibility analysis, but in discussions with the WSDOT Load Rating Engineer, it is likely the rating would approach 0.9 if an additional overlay, over the existing, were added to the bridge. The two options for dealing with the low rating are 1: strengthen the members that are under capacity or 2: allow the heavy truckloads to run on the bridge with the low rating.

The first option would require significant costly modifications to the existing bridge superstructure. One of the critical elements controlling the current bridge rating is the longitudinal deck stringers on the truss. As discussed in the original feasibility report, the bridge received a seismic upgrade in the mid 1990s. The deck stringers were not rehabilitated during the seismic upgrade. The focus of the upgrade was on the substructure and bearings, which must resist and transfer seismic loads to the foundation. The additional weight from the overlay would likely not be a problem to the substructure or bearings. However, placing more dead load, i.e., an additional overlay, would reduce the live load capacity of the stringers, thereby requiring many or all the deck stringers to be strengthened. The exact cost to modify the bridge for additional dead load is unknown but could likely be in excess of $10 million.

The second option of allowing the heavy truck loads to use the bridge with the reduced load rating would cause the bridge to deteriorate faster and may cause fatigue problems in the overloaded members. This is not an acceptable option.

Another problem with placing a HMA overlay on the existing concrete overlay is that the current condition of the concrete overlay is in need of repairs. From the latest inspection reports, approximately 12% of the existing overlay is in need or has recently been repaired. This is an ongoing effort for the WSDOT Bridge Maintenance crews. Identifying and repairing discrete locations along the bridge can be nearly as expensive as removing the entire overlay. If the HMA overlay were placed directly on the concrete overlay without repairs, the life of the HMA would be significantly reduced.

For the reasons stated above, it is assumed the existing concrete overlay would be removed if an HMA and membrane overlay was allowed to be placed on the bridge. Costs for placing a HMA overlay on top of the existing concrete overlay will not be presented in this report.

S1.5 Cost to Add a HMA with Membrane Overlay

The costs for the HMA with a polymer membrane overlay combination are approximately $3.5 million in 2004 dollars (3% per year inflation should be assumed if this effort is chosen for implementation in a future year). These costs are for the lower deck of the Ship Canal Bridge. The cost includes the major bridge items and does not include sales tax, contingencies, engineering, inflation, any typical Region items, or maintenance and future replacement. However, from evaluation of final costs on previous projects, a one-time typical total project cost for this type of work has been in the range of $50 to $60 per square foot. Using these values the total project cost for adding a HMA overlay to the lower deck of the Ship Canal Bridge could range from $9.6 to $11.6 million in 2004 dollars.

S2. SUMMARY

The Bridge and Structures Office does not recommend placing a HMA overlay on the lower deck of the Ship Canal Bridge. However, if it was found to be necessary, removing the existing aging concrete overlay and replacing it with a thin polymer and HMA combination would be more acceptable than adding a HMA overlay on top of the existing LMC overlay. Therefore, with no significant change in weight or loading to critical members, the concept is structurally feasible.

As an alternative to placing a HMA overlay the following should be considered. The existing LMC overlay is aging and will need replacement. WSDOT will likely choose to replace the existing overlay with another modified concrete or a 1-inch thick polyester concrete overlay. There have been limited studies performed in the past, which showed the wheel-to-roadway generated noise for polyester concrete is somewhat less than normal concrete decks and was similar to that of normal hot mix asphalt. Studies would need to be performed to compare the sound qualities of the polyester concrete with the modified pavement designs shown in Table 1. However, the polyester concrete overlay may be a solution that could meet both sound reduction and deck protection objectives. The polyester concrete overlay would have a life span of approximately 20 years, versus 4 to 6 with HMA. The polyester concrete provides a superior deck protection system compared to the HMA and membrane combination. The costs for placing the polyester overlay would be comparable to the HMA and membrane combination.

APPENDIX G: Modeling Results

1999 Traffic Noise Levels

1999 peak hour traffic volumes were substituted into the previous 2004 models to determine the 1999 modeled direct path and reflected path noise levels. In addition, noise walls were placed in the 1999 models to allow us to model noise levels for wall panels of different heights. In each quadrant three noise walls were modeled: An at-grade concrete noise wall; a noise wall on top of the existing I-5 mainline crash barrier; and a noise wall on top of the existing express lane crash barrier. Adjustment factors from the calibration step above were added to all 1999 models.

SW Quadrant

Combined 1999 modeled noise levels for all receivers in the SW quadrant ranged from 72 dBA to 87 dBA (Table I-2).

SE Quadrant

Combined 1999 modeled noise levels for all receivers in the SE quadrant ranged from 67 dBA to 83 dBA (Table J-2).

NE Quadrant

Combined 1999 modeled noise levels for all receivers in the NE quadrant ranged from 66 dBA to 84 dBA (Table K-2).

NW Quadrant

Combined 1999 modeled noise levels for all receivers in the NW quadrant ranged from 67 dBA to 85 dBA (Table L-2).

Noise Reduction

This study analyzes two types of noise reduction methods: walls that reflect sound, and material that absorbs sound. Noise walls provide a barrier of solid material between the noise source and the person hearing the noise. The noise hits the barrier and is reflected away from the barrier, blocking the noise. This is called sound reflection (Figure 10)

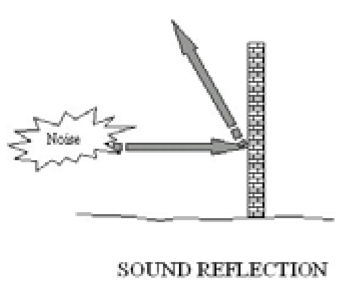


Figure 8: Sound Reflecting Noise Wall Diagram

In addition to the noise walls that reflect the noise, other materials can absorb sound. Sound pressure enters the absorptive material, containing open spaces in which the sound pressure is discharged. This is called sound absorption (Figure 11).

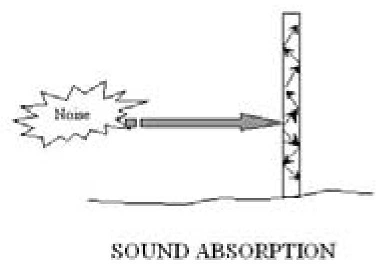


Figure 9: Sound Absorptive Noise Wall Diagram

To determine how to obtain the greatest noise reduction, reflective noise walls were first analyzed. Two wall scenarios were evaluated for each quadrant. The scenario with the greatest noise reduction was selected. Then, sound absorbing materials were evaluated in conjunction with the selected noise wall scenario.

Noise Walls

Noise Wall Locations

At-grade (mounted on the ground) and on structure (mounted on the bridge) noise walls were modeled separately for each quadrant (Figure 12). The at-grade noise walls were modeled to reduce direct path noise primarily for the portion of the express lanes and I-5 mainline that were at or near ground level.

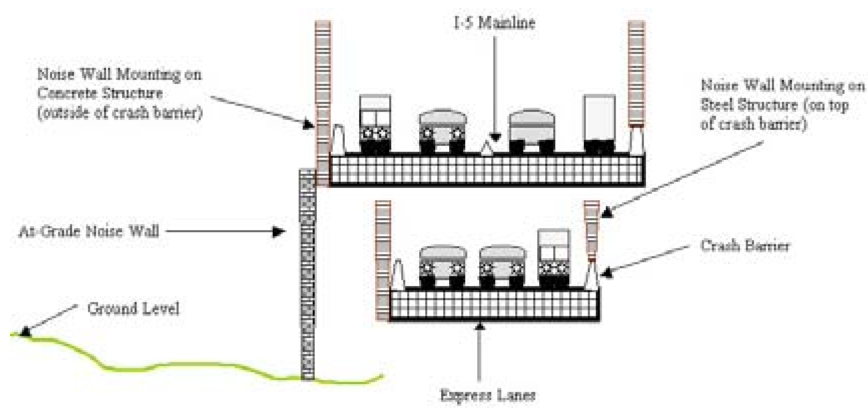


Figure 10: Sound Absorptive Noise Wall Diagram

The on-structure noise walls were modeled to reduce direct path noise from the I-5 mainline and express lanes and some reflected noise from the express lanes. The noise walls were also modeled to provide some overlap where the at-grade noise walls end and the on-structure noise walls begin to provide adequate protections. The noise walls in the southern portion of the current study area will be tied into noise walls that are proposed for the I-5 Rehabilitation Project.

The at-grade concrete and lightweight noise walls (on structure) were first modeled to determine the appropriate height and length based on total noise reduction. When sound reflective materials such as Quilite® and Paraglass Soundstop© were modeled on structure the standard TNM reflective noise wall modeling was assumed.

Scenario 1

Scenario 1 includes modeling of at-grade, express lane, and mainline noise walls together as a system. The modeling included direct and reflected noise paths. Modeling all three walls will determine how the walls worked together to reduce noise and whether all three walls will be necessary for noise reduction.

Scenario 2

Scenario 2 modeled only the noise walls on the express lanes and the I-5 mainline. For both scenarios the direct path and reflected path noise levels were combined logarithmically to determine the combined noise levels for each scenario. Finally, the combined noise levels from each scenario were subtracted from the 1999 combined noise levels (without the noise walls) to determine the total noise reduction for each receiver.

Scenario Selection

The scenario chosen for the final wall configuration was the scenario with the most receivers having a higher noise reduction than the other scenario. This allowed us to both determine if any of the wall panels were redundant thereby achieving a cost savings and still provide the best possible noise reductions. This process was repeated for each quadrant.

SW Quadrant

Our noise wall analysis found that noise reductions achieved by including the concrete wall (SW Wall 1) in the model resulted in only four receivers with higher noise reductions than without the concrete wall. There were a total of 12 receivers with higher reductions without the concrete wall. Therefore, two noise walls located where the existing I-5 mainline and express lane west crash barriers exist are proposed. Total reduced noise levels for Scenario 2 ranged between 66 dBA and 83 dBA with total noise reductions between 0 dBA and eight dBA for reflective noise walls only (Table I-3).

SW Wall 2

This noise wall is located on top of or just outside of the existing I-5 mainline crash barrier. Wall SW Wall 2 is approximately 2,440 feet long with an average height of nine feet. Total surface area of SW Wall 2 is approximately 22,640 sq. ft. The southern end of the wall starts at-grade at E. Edgar street at 11 feet high and continues north for 300 feet where it transitions to on-structure. The wall increases in height to 13 feet for another 200 feet north. The wall then reaches its maximum height of 15 feet for approximately 100 feet then drops down to 11 feet in height for approximately 240 feet. The wall then drops down to nine feet in height for approximately 700 feet then finally dropping again to seven feet in height for approximately 900 feet where it terminates between E. Allison and Fairview Ave. E.

SW Wall 3

The noise wall is located on the west side of the express lanes on top of or in place of the existing crash barrier. Wall SW Wall 2 is approximately 1,520 feet long with an average height of 22 feet. Total surface area of SW Wall 1 is approximately 26,618 sq. ft. The southern end of the wall starts at-grade where the express lanes become exposed on the west side about 250 feet north of E. Hamlin. The wall continues north to Pier 11 and completely fills the vertical space between the express lanes and the bottom of the I-5 mainline. North of Pier 11 the wall is 30 feet high for approximately 500 feet where it transitions to on-structure, then it decreases in height to 12 feet for approximately 365 feet north. Then the wall height decreases to nine feet high for approximately 342 feet where it terminates just above Fairview Ave. E.

SE Quadrant

Our noise wall analysis found that noise reductions achieved by including the concrete wall (SE Wall 1) in the model resulted in 25 receivers with higher noise reductions than without the concrete wall. There were only two receivers with higher reductions without the concrete wall. Therefore, three noise walls, an at-grade concrete noise wall and two noise walls each located where the existing I-5 mainline and express lane east crash barriers exist, are proposed (Figure 9). Total reduced noise levels for Scenario 1 ranged between 62 and 82 dBA with total noise reductions between 0 and 10 dBA for reflective noise walls (Table J-3).

SE Wall 1

Noise wall SE Wall 1 is an at-grade concrete wall located immediately east of the I-5 mainline crash barrier. The wall is approximately 700 feet long with an average height of 16 feet. Total surface area of SE Wall 1 is approximately 11,000 sq. ft. The southern part of the wall starts approximately 200 feet north of the I-5 mainline on-ramp near E. Hamlin where it is 16 feet tall for 100 feet. The wall height then increases to 18 feet for 250 feet then decreases to 14 feet high for the final 350 feet where it terminates at E. Allison.

SE Wall 2

Noise wall SE Wall 2 is approximately 2,288 feet long with an average height of five feet located on to of or just outside of the existing I-5 mainline crash barrier. Total surface area of SW Wall 2 is approximately 22,563 sq. ft. The southern point of the wall starts as an at-grade wall just north of the I-5 mainline on-ramp near E. Hamlin where the wall height is 20 feet for 235 feet. The wall then transitions to on-structure and the height decreases slightly to 19 feet for approximately 232 feet. The wall height decreases to 15 feet for 122 feet and then decreases further to nine feet tall for approximately 400 feet. The wall decreases again in height to seven feet for approximately 765 feet and then finally decreases in height to five feet for the final 534 feet where it terminates above Fuhrman Avenue E. near Fairview Ave. E.

SE Wall 3

Noise wall SE Wall 3 is approximately 2,400 feet long with an average height of 13 feet. Total surface area of SW Wall 3 is approximately 43,377 sq. ft. and is located on top of or just outside of the existing east express lanes crash barrier. The southern end of the wall starts as an at-grade wall where the current express lanes crash barrier exists. The wall starts where the express lanes become exposed on the east side near E. Shelby and continues north to Pier 11 completely filling the vertical space between the express lanes and the bottom of the I-5 mainline. North of Pier 11 the wall ties into the existing crash barrier until approximately 115 feet south of E. Allison where the wall begins again on-structure at a height of nine feet for approximately 115 feet. The wall then decreases in height to seven feet for the next 300 feet and then increases to 29 feet for approximately 365 feet. The wall then reaches its maximum height of 30 feet (spanning the height between express lanes and bottom of mainline) for approximately 532 feet. Then the wall decreases to 23 feet high approximately 161 feet and finally decreases to 19 feet for approximately 526 feet where it terminates above the northern shore of the Ship Canal where it will presumably tie into the noise wall in the NE quadrant.

NE Quadrant

Our noise wall analysis found that noise reductions achieved by including the concrete wall (NE Wall 1) in the model resulted in 44 receivers with higher noise reductions than without the concrete wall. There were no receivers with higher reductions without the concrete wall. Therefore, three noise walls, an at-grade noise wall, and noise walls each located where the existing I-5 mainline and express lane east crash barriers exist, are proposed (Figure 9). Total reduced noise levels for Scenario 1 ranged between 62 and 81 dBA with total noise reductions between 1.1 dBA and 11.4 dBA for reflective noise walls (Table K-3).

NE Wall 1

Noise wall, NE Wall 1, is an at-grade concrete noise wall located immediately east of the NE 45th St. off-ramp. The total length is 1000 feet long with an average height of 13 feet. Total surface area of NE Wall 1 is approximately 13,400 sq. ft. The northern end of the wall starts approximately 100 feet south of 7th Avenue NE and immediately east of the on-ramp where the wall is 10 feet tall for 50 feet. Then the wall continues south for 150 feet at 16 feet tall. The wall decreases in height to 12 feet for 50 feet and again to eight feet for 150 feet. The wall increases slightly again to 12 feet for 50 feet and then decreases to eight feet for 150 feet. The wall then continues south for 100 feet at 14 feet high. Then increases to 16 feet for 150 feet, up to 22 feet for 50 feet and then decreases to 20 feet for 100 feet where the wall terminates approximately 50 feet south of NE 42nd street.

NE Wall 2

Noise wall, NE Wall 2, is approximately 535 feet long with an average height of nine feet. Total surface area of NE Wall 2 is approximately 4,909 sq. ft. The wall is located where the existing I-5 mainline crash barrier is located. The northern end of the wall starts as an at-grade wall near NE 43rd St. where the wall height is 11 feet for 327 feet to the south. The wall then decreases to five feet high for 72 feet and then increases to seven feet for 136 feet to the south where it transitions to on structure and ties into the existing crash barrier.

NE Wall 3

Noise wall, NE Wall 3, is approximately 1,548 feet long and ties directly into the SE Wall 3. NE Wall 3 has an average height of five feet. Total surface area of NE Wall 3 is approximately 9,814 sq. ft. The northern end of the wall starts as an at-grade wall where the current express lanes crash barrier exists. The barrier starts where the express lanes become exposed on the east side approximately 250 feet north of NE 42nd St. and continues south to Pier 28 completely filling the vertical space between the express lanes and the bottom of the I-5 mainline. South of Pier 28 the noise wall returns to the existing crash barrier height until approximately 90 feet north of the NE 42nd St. on-ramp where the wall is seven feet high and the wall is on structure. South of the NE 42nd St on-ramp the barrier continues at seven feet high for another 90 feet and then decreases to the existing crash barrier height for approximately 186 feet. The wall then increases in height to seven feet for approximately 625 feet where it ties into the SE Wall 3 wall.

NW Quadrant

Our noise wall analysis found that noise reductions achieved by including the concrete wall (NW Wall 1) in the model resulted in only 14 receivers with higher noise reductions than without the concrete wall. There were a total of 27 receivers with higher reductions without the concrete wall. Therefore, two noise walls, each located where the existing I-5 mainline and express lane west crash barriers exist are proposed (Figure 9). Total reduced noise levels for Scenario 2 ranged between 64 dBA and 81 dBA with total noise reductions between 1.7 dBA and 6.2 dBA for reflective noise walls (Table L-3).

NW Wall 2

Noise wall NW Wall 2 total length is approximately 2,079 feet long with an average height of eight feet. Total surface area of NW Wall 2 is approximately 18,075 sq. ft. The wall is located where the existing I-5 mainline crash barrier is located. The northern end of the wall starts at-grade at NE 43rd Street where the wall height is 15 feet for 158 feet to the south. The wall then decreases to 13 feet for 170 feet, 11 feet for 72 feet then increases again to 13 feet for 135 feet. The wall then decreases to nine feet for 155 feet and down to seven feet for 62 feet where it ties into the existing crash barrier. The wall starts again further south approximately 250 feet north of NE 40th Street at nine feet tall for 180 feet where it ties into the existing crash barrier on both ends. The wall starts again further south immediately south of NE 40th at nine feet tall for 261 feet, then decreases to seven feet for 360 feet and then down to five feet for 526 feet where it and will tie into the SW Wall 2.

NW Wall 3

Barrier NW Wall 3, is approximately 1,767 feet long and ties directly into the SW Wall 3. NW Wall 3 has an average height of 14 feet. Total surface area of NW Wall 3 is approximately 26,097 sq. ft. The northern end of the wall starts as an on-structure wall where the current express lanes crash barrier exists. The barrier starts where the express lanes become exposed on the west side approximately 250 feet north of NE 42nd St. and continues south to Pier 28 (approximately 240 feet) completely filling the vertical space between the express lanes and the bottom of the I-5 mainline. South of Pier 28 the noise wall is 15 feet high for approximately 377 feet where it ties into the existing crash barrier. The noise wall starts again further south just south of NE 40th Street at nine feet tall for 264 feet. Then the wall increases to 11 feet for 360 feet and then increases to 21 feet for 526 feet where it ties into the SW Wall 3 wall.

Absorptive Materials

Additional noise reductions were calculated for absorptive materials using an Excel spreadsheet. The spreadsheet calculated the additional noise reduction achieved by each of the four different noise absorptive materials analyzed. A review of these materials can be found in the WSDOT report titled *State Route 520 Alternative Noise Barrier Materials Research Report*, July 2004. In addition a fifth absorptive material analyzed in the original report, Noiseshield Type FS, was analyzed. Two of the absorptive materials (Acoustax and Silent Screen) are similar products with similar properties and therefore were analyzed as one material.

Noise reductions from absorptive materials were calculated by dividing the Noise Reduction Coefficient (NRC) of the absorptive material by the NRC for concrete (0.08). This ratio is then converted to a log and multiplied by 10 resulting in the decibel equivalent of the noise reduction. This decibel reduction is then subtracted from the 1999 direct path, for vertical walls, and reflected path, for horizontal panels suspended from the bottom of the I-5 mainline. These reflected and direct path noise levels were then combined logarithmically to determine the combined noise levels for each receiver in each quadrant. This process was repeated for each different absorptive material.

To determine the best combination of reflective and absorptive noise wall materials resulting in the greatest noise reduction, five different vertical noise wall and horizontal panel configurations were compared.

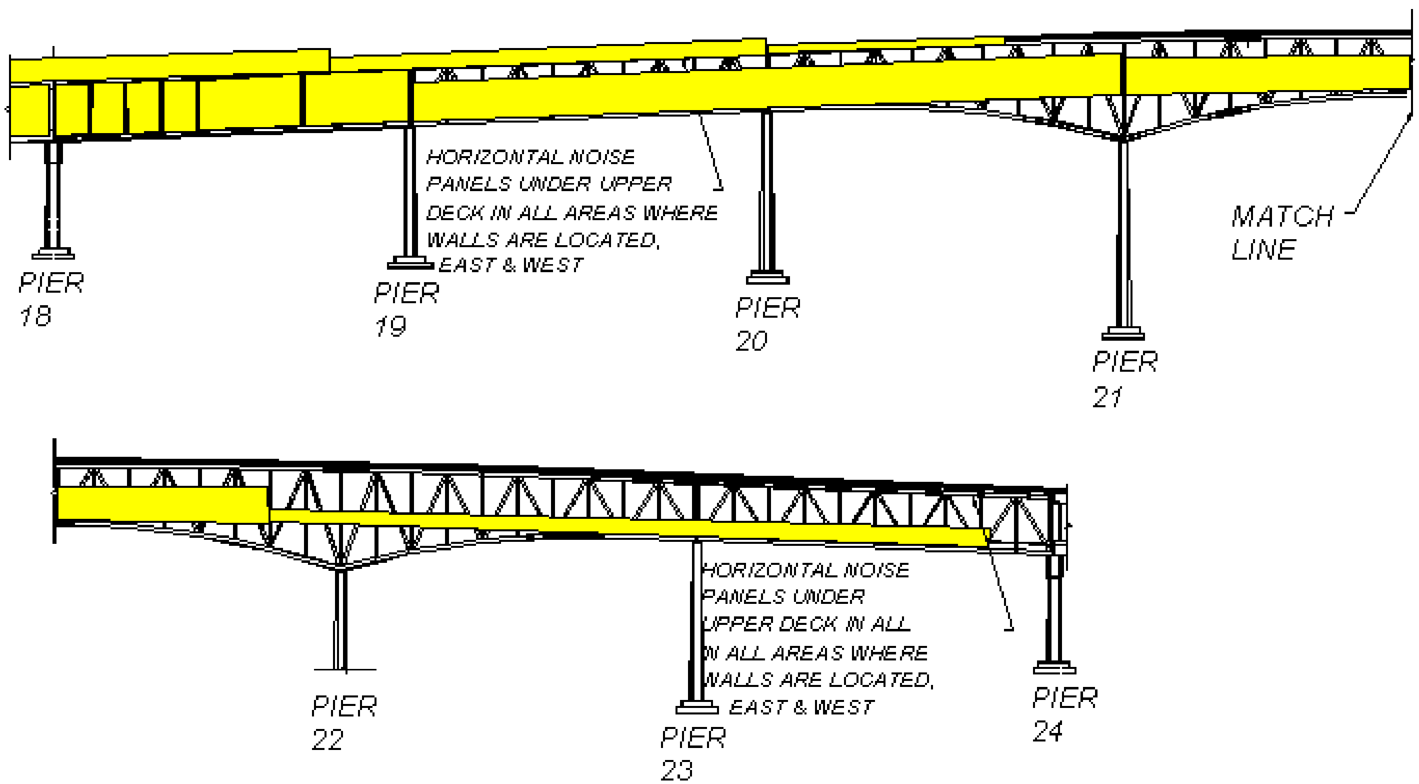
- Reflective noise walls only;
- Absorptive noise walls only;
- Absorptive materials on the bottom of the I-5 mainline only;
- Reflective noise walls and absorptive materials on the bottom of the I-5 mainline;
- Absorptive noise walls and absorptive materials on the bottom of the I-5 mainline.

For each of the five configurations the direct path and reflective path noise levels were combined logarithmically and then subtracted from the combined 1999 noise levels (without a noise wall) to determine the overall noise reduction for each configuration. The configuration with the highest overall noise reductions for each absorptive material was chosen for final consideration in the analysis.

A comparison of the sound reduction capabilities of each material is presented in this report in appendices Tables I-4 to I-7 , J-4 to J-7, K-4 to K-7, and L-4 to L-7 by quadrant. Acoustax, Silent Screen, Sound Fighter, and Noiseshield had very similar sound reductions ranging between 12 dBA and 19 dBA. Only in the SE and NE quadrants did Acoustax and Silent Screen produce slightly higher noise reductions on the order of one dBA. In all quadrants Carsonite Composite Panels consistently had lower sound reductions due to its lower NRC relative to the other materials. Noise reductions for Carsonite ranged from five to 10 dBA (Tables I-to L-6).

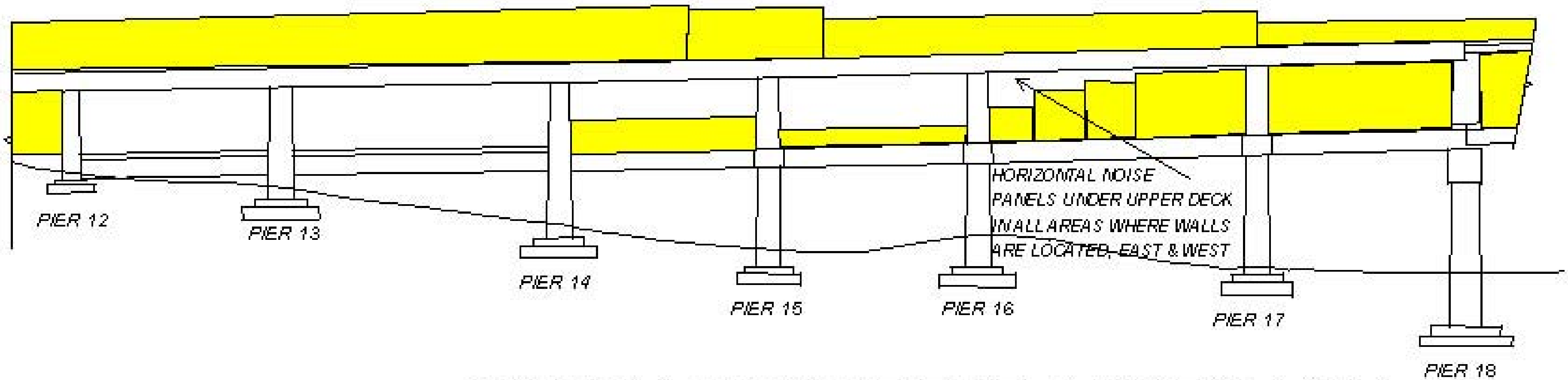
APPENDIX H: Diagrammatic Side Views of Proposed noise Walls

The yellow wall panels are on the east side of the bridge. The green wall panels are on the west side of the bridge (background).



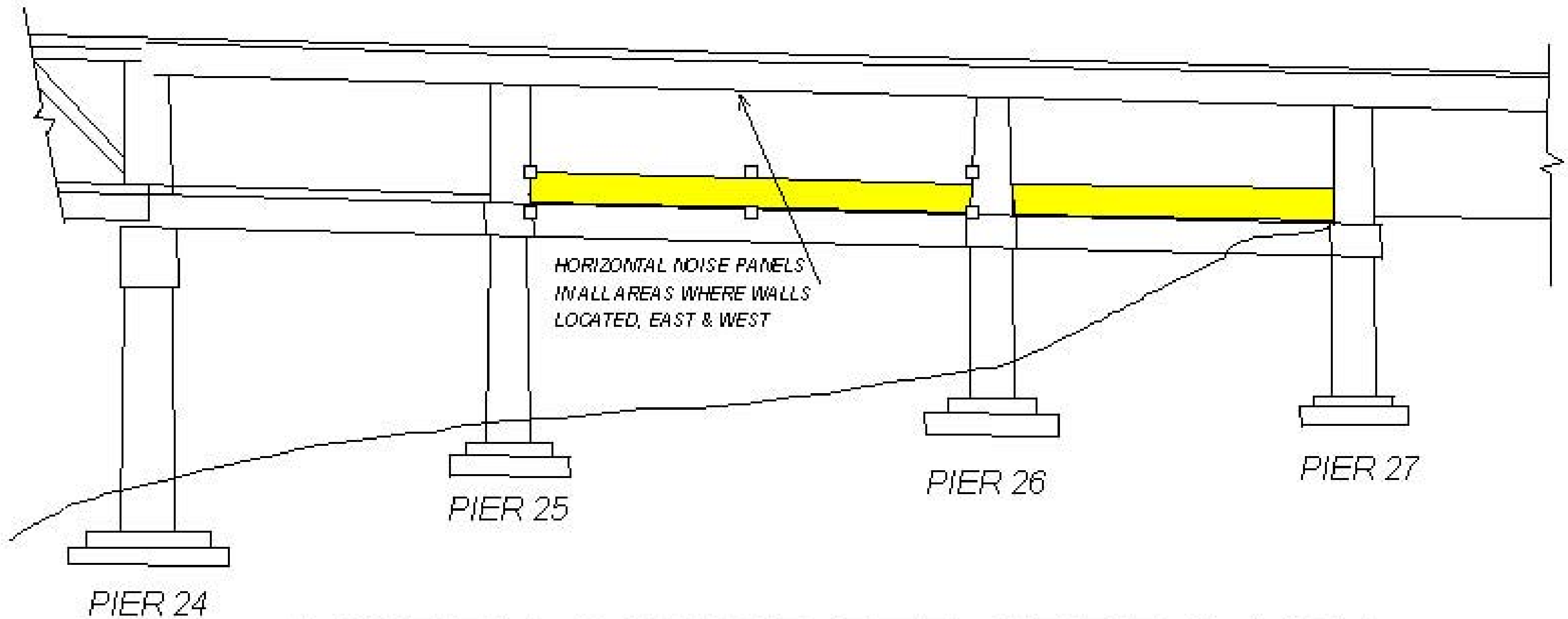
STEEL TRUSS – MAIN SPAN

FACING WEST – EAST SIDE SHOWN



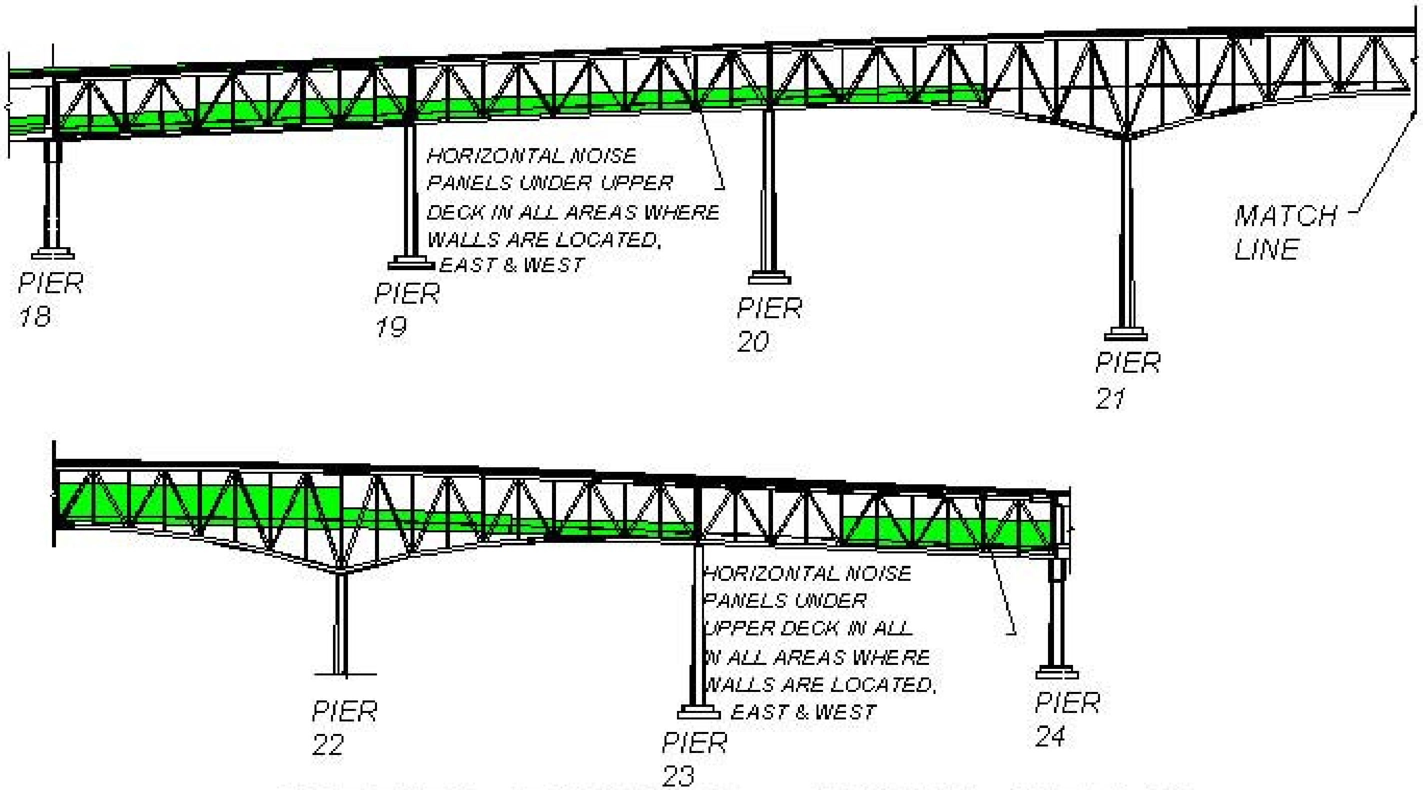
SOUTH CONCRETE APPROACH

FACING WEST – EAST SIDE WALLS SHOWN



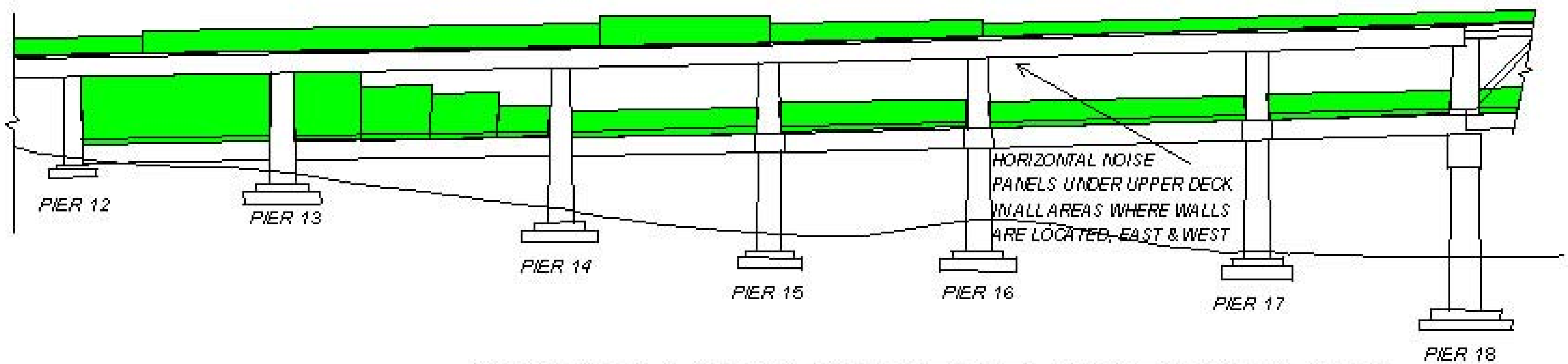
NORTH CONCRETE APPROACH

FACING WEST – EAST SIDE WALLS SHOWN



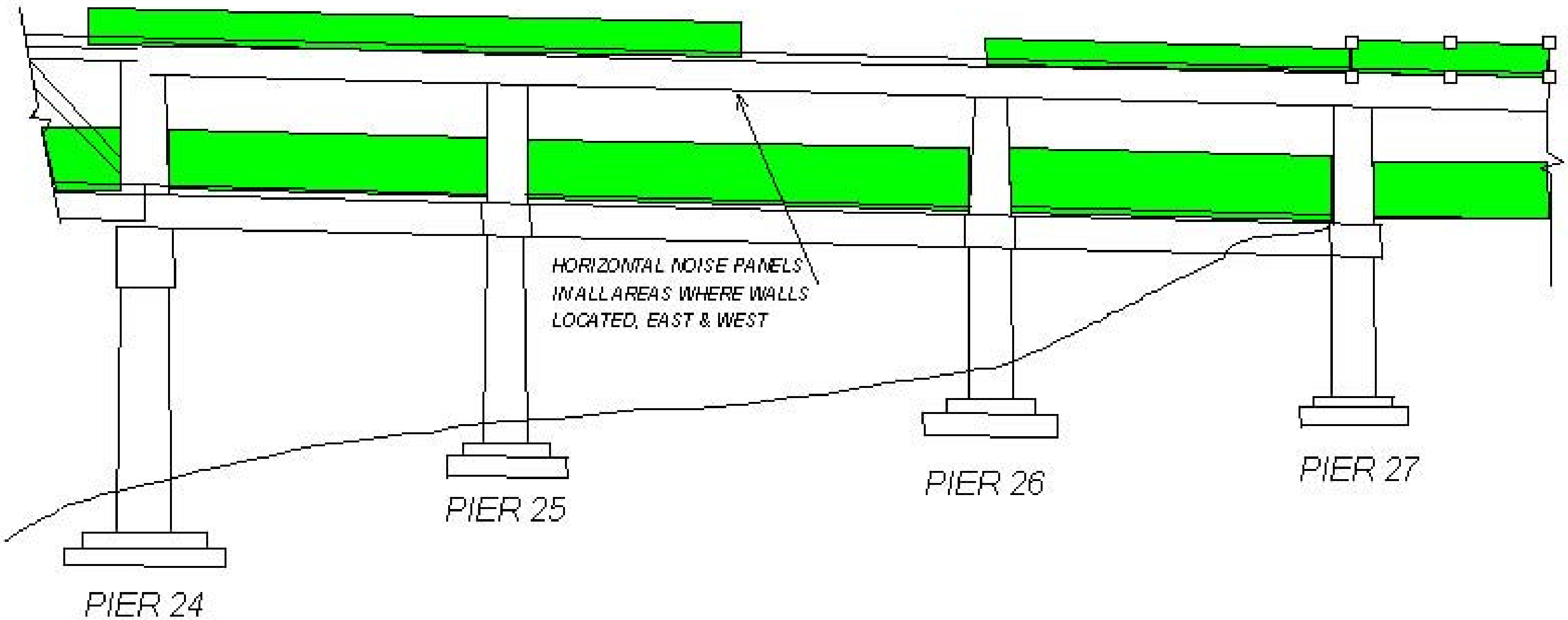
STEEL TRUSS – MAIN SPAN

FACING WEST – WEST SIDE SHOWN



SOUTH CONCRETE APPROACH

FACING WEST – WEST SIDE WALLS SHOWN



NORTH CONCRETE APPROACH

FACING WEST – WEST SIDE WALLS SHOWN

APPENDIX I: Southwest Quadrant Noise Level Results

Table I-1: Existing (2004) Modeled Traffic Noise Levels (SW Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq}	Households	Type[1]
Fairview Park	**69**	**72**	**74**	1	P
Good Turn Park	**74**	**78**	**79**	1	P
M-1	**77**	N/A	**77**	2	SF
M-12 (Northern Passage Pt. Park)	**69**	**82**	**82**	1	P
M-5	**85**	**84**	**88**	1	MF
M-8	**78**	**82**	**84**	1	P
SW1-1	**70**	**81**	**82**	1	SF
SW1-2	**73**	**78**	**80**	1	C
SW1-3	**78**	**83**	**84**	16	MF
SW1-4	**84**	**82**	**86**	12	MF
SW1-5	**79**	N/A	**79**	33	MF
SW1-6	**83**	**78**	**84**	21	MF
SW1-7	**77**	**79**	**81**	6	SF
SW1-8	**74**	**77**	**79**	12	MF
SW2-1	**70**	**75**	**76**	30	MF
SW2-2	**76**	N/A	**76**	16	MF
SW2-3	**79**	**72**	**80**	12	MF
SW2-4	**73**	N/A	**73**	16	MF
SW2-5	**76**	**70**	**77**	11	MF
SW2-6	**78**	**78**	**81**	18	MF
SW3-1	**71**	**74**	**76**	8	SF
SW3-2	**68**	N/A	**68**	3	SF
SW3-3	**70**	N/A	**70**	6	SF
SW3-4	**71**	**71**	**74**	39	MF
SW3-5	**76**	**73**	**78**	25	MF
SW3-6	**70**	**73**	**75**	4	SF
SW3-7	**72**	**75**	**76**	2	SF
SW3-8	**73**	**75**	**77**	4	SF
Tyee Yacht Club	**71**	**81**	**81**	4	C

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility.

Table I-2: 1999 Modeled Traffic Noise Levels (SW Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
Fairview Park	**69**	**73**	**74**	1	P
Good Turn Park	**74**	**78**	**79**	1	P
M-1	**82**	N/A	**82**	2	SF
M-12	**69**	**81**	**82**	1	P
M-5	**85**	**84**	**87**	1	MF
M-8	**78**	**82**	**83**	1	P
SW1-1	**70**	**81**	**81**	1	SF
SW1-2	**73**	**78**	**79**	1	C
SW1-3	**78**	**83**	**84**	16	MF
SW1-4	**83**	**82**	**86**	12	MF
SW1-5	**80**	N/A	**80**	33	MF
SW1-6	**83**	**81**	**85**	21	MF
SW1-7	**77**	**79**	**81**	6	SF
SW1-8	**74**	**77**	**79**	12	MF
SW2-1	**70**	**75**	**76**	30	MF
SW2-2	**77**	N/A	**77**	16	MF
SW2-3	**79**	**78**	**82**	12	MF
SW2-4	**75**	N/A	**75**	16	MF
SW2-5	**77**	**76**	**79**	11	MF
SW2-6	**77**	**78**	**81**	18	MF
SW3-1	**72**	**74**	**76**	8	SF
SW3-2	**71**	N/A	**71**	3	SF
SW3-3	**69**	N/A	**69**	6	SF
SW3-4	**71**	**75**	**76**	39	MF
SW3-5	**75**	**77**	**79**	25	MF
SW3-6	**70**	**74**	**75**	4	SF
SW3-7	**72**	**75**	**77**	2	SF
SW3-8	**73**	**74**	**77**	4	SF
TYEE-Yacht Club	**71**	**81**	**81**	4	C

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility

Table I-3: Total Direct Path Noise Reduction Provided With and Without an At-Grade Noise Wall (SW Quadrant)

Site	1999 No Wall[1] (dBA)	Scenario 1			
		Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
Fairview Park	**74**	**68**	**70**	**72**	2.3
Good Turn Park	**79**	**72**	**76**	**77**	1.5
M-1	**82**	**76**	N/A	**76**	5.9
M-12	**82**	**68**	**81**	**81**	0.4
M-5	**87**	**79**	**80**	**83**	5.0
M-8	**83**	**75**	**81**	**82**	1.3
SW1-1	**81**	**69**	**81**	**81**	0.0
SW1-2	**79**	**70**	**76**	**77**	2.2
SW1-3	**84**	**75**	**83**	**84**	0.4
SW1-4	**86**	**78**	**79**	**82**	4.2
SW1-5	**80**	**75**	N/A	**75**	5.0
SW1-6	**85**	**76**	**71**	**77**	7.6
SW1-7	**81**	**75**	**76**	**79**	2.3
SW1-8	**79**	**72**	**74**	**76**	2.6
SW2-1	**76**	**68**	**73**	**74**	2.1
SW2-2	**77**	**72**	N/A	**72**	5.2
SW2-3	**82**	**73**	**68**	**74**	7.4
SW2-4	**75**	**69**	0	**69**	5.5
SW2-5	**79**	**71**	**67**	**72**	6.9
SW2-6	**81**	**74**	**75**	**78**	3.1
SW3-1	**76**	**70**	**72**	**74**	1.9
SW3-2	**71**	**67**	N/A	**67**	4.3
SW3-3	**69**	**67**	N/A	**67**	2.1
SW3-4	**76**	**68**	**68**	**71**	5.5
SW3-5	**79**	**71**	**69**	**73**	5.7
SW3-6	**75**	**69**	**71**	**73**	2.2
SW3-7	**77**	**70**	**72**	**74**	2.4
SW3-8	**77**	**71**	**72**	**75**	2.3
TYEE-Yacht Club	**81**	**70**	**81**	**81**	0.0
Total Reductions Greater Than Scenario 2:					**4**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.
N/A – Not applicable, no reflected noise at this location.
[1] – From Table I-2

Table I-3 Cont'd

Site	1999 No Wall[1] (dBA)	Scenario 2 Direct Path With Wall (dBA)	Scenario 2 Reflected Path With Wall (dBA)	Scenario 2 Combined Noise (dBA)	Scenario 2 Noise Reduction
Fairview Park	**74**	**66**	**70**	**71**	3.0
Good Turn Park	**79**	**71**	**75**	**76**	2.5
M-1	**82**	**74**	N/A	**74**	7.9
M-12	**82**	**68**	**81**	**81**	0.4
M-5	**87**	**79**	**80**	**83**	5.0
M-8	**83**	**75**	**79**	**80**	2.8
SW1-1	**81**	**69**	**81**	**81**	0.0
SW1-2	**79**	**70**	**76**	**77**	2.2
SW1-3	**84**	**75**	**81**	**82**	2.1
SW1-4	**86**	**78**	**79**	**82**	4.2
SW1-5	**80**	**74**	N/A	**74**	6.0
SW1-6	**85**	**77**	**72**	**78**	6.6
SW1-7	**81**	**74**	**76**	**78**	2.8
SW1-8	**79**	**72**	**74**	**76**	2.6
SW2-1	**76**	**68**	**73**	**74**	2.1
SW2-2	**77**	**71**	N/A	**71**	6.2
SW2-3	**82**	**73**	**69**	**74**	7.2
SW2-4	**75**	**69**	0	**69**	5.5
SW2-5	**79**	**71**	**68**	**73**	6.6
SW2-6	**81**	**74**	**75**	**78**	3.1
SW3-1	**76**	**69**	**72**	**74**	2.3
SW3-2	**71**	**66**	N/A	**66**	5.3
SW3-3	**69**	**67**	N/A	**67**	2.1
SW3-4	**76**	**68**	**68**	**71**	5.5
SW3-5	**79**	**71**	**70**	**74**	5.3
SW3-6	**75**	**67**	**70**	**72**	3.6
SW3-7	**77**	**69**	**72**	**74**	2.8
SW3-8	**77**	**71**	**72**	**75**	2.3
TYEE-Yacht Club	**81**	**70**	**81**	**81**	0.0
Total Reductions Greater Than Scenario 1:					**12**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.
N/A – Not applicable, no reflected noise at this location.
[1] – From Table I-2

Table I-4: Comparison of Total Additional Noise Reduction Provided by Acoustax/Silent Screen Absorptive Materials (SW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**71**	3.0	**70**	4.3	**69**	5.0
Good Turn Park	**79**	**76**	2.5	**75**	3.9	**74**	4.7
M-1	**82**	**74**	7.9	63	19.4	**82**	0.0
M-12	**82**	**81**	0.4	**81**	0.6	**73**	9.1
M-5	**87**	**83**	5.0	**80**	7.3	**85**	2.3
M-8	**83**	**80**	2.8	**79**	4.2	**78**	4.9
SW1-1	**81**	**81**	0.0	**81**	0.2	**73**	8.5
SW1-2	**79**	**77**	2.2	**76**	3.1	**74**	5.7
SW1-3	**84**	**82**	2.1	**81**	3.0	**79**	5.4
SW1-4	**86**	**82**	4.2	**79**	6.5	**83**	2.3
SW1-5	**80**	**74**	6.0	63	17.5	**80**	0.0
SW1-6	**85**	**78**	6.6	**73**	11.9	**83**	1.9
SW1-7	**81**	**78**	2.8	**76**	4.7	**77**	3.5
SW1-8	**79**	**76**	2.6	**74**	4.6	**75**	3.9
SW2-1	**76**	**74**	2.1	**73**	3.2	**71**	5.6
SW2-2	**77**	**71**	6.2	60	17.7	**77**	0.0
SW2-3	**82**	**74**	7.2	**70**	11.9	**80**	2.0
SW2-4	**75**	**69**	5.5	58	17.0	**75**	0.0
SW2-5	**79**	**73**	6.6	**69**	10.8	**77**	2.5
SW2-6	**81**	**78**	3.1	**75**	5.4	**78**	3.1
SW3-1	**76**	**74**	2.3	**72**	3.9	**72**	3.8
SW3-2	**71**	**66**	5.3	55	16.8	**71**	0.0
SW3-3	**69**	**67**	2.1	56	13.6	**69**	0.0
SW3-4	**76**	**71**	5.5	**68**	8.2	**71**	5.1
SW3-5	**79**	**74**	5.3	**70**	8.5	**75**	3.4
SW3-6	**75**	**72**	3.6	**70**	5.2	**70**	5.0
SW3-7	**77**	**74**	2.8	**72**	4.4	**72**	4.1

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW3-8	**77**	**75**	2.3	**72**	4.6	**74**	3.2
TYEE-Yacht Club	**81**	**81**	0.0	**81**	0.0	**73**	7.9

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

1 – From Table I-2.

2 – From Scenario 2 (Table I-3).

Table I-4 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**67**	7.7	60	14.5
Good Turn Park	**79**	**72**	7.3	65	14.0
M-1	**82**	**74**	7.9	63	19.4
M-12	**82**	**72**	9.8	**70**	11.9
M-5	**87**	**79**	8.1	**71**	16.4
M-8	**83**	**76**	7.6	**69**	14.3
SW1-1	**81**	**72**	9.0	**70**	11.4
SW1-2	**79**	**71**	8.1	**66**	13.6
SW1-3	**84**	**76**	8.0	**71**	13.6
SW1-4	**86**	**78**	7.3	**70**	15.6
SW1-5	**80**	**74**	6.0	63	17.5
SW1-6	**85**	**77**	7.7	**67**	18.1
SW1-7	**81**	**74**	6.4	**67**	14.2
SW1-8	**79**	**72**	6.3	65	14.1
SW2-1	**76**	**69**	7.4	63	13.5
SW2-2	**77**	**71**	6.2	60	17.7

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW2-3	**82**	**73**	8.5	63	18.6
SW2-4	**75**	**69**	5.5	58	17.0
SW2-5	**79**	**71**	8.2	61	18.1
SW2-6	**81**	**74**	6.3	**66**	14.6
SW3-1	**76**	**70**	6.5	62	13.7
SW3-2	**71**	**66**	5.3	55	16.8
SW3-3	**69**	**67**	2.1	56	13.6
SW3-4	**76**	**68**	8.2	60	16.9
SW3-5	**79**	**71**	7.6	62	16.7
SW3-6	**75**	**68**	7.7	60	15.0
SW3-7	**77**	**70**	7.0	62	14.2
SW3-8	**77**	**71**	5.5	63	13.8
TYEE-Yacht Club	**81**	**73**	8.2	**70**	11.1

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table I-2.

[2] – From Scenario 2 (Table I-3).

Table I-5: Comparison of Total Additional Noise Reduction Provided by Sound Fighter Systems Absorptive Materials (SW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**71**	3.0	**70**	4.3	**69**	5.0
Good Turn Park	**79**	**76**	2.5	**75**	3.9	**74**	4.7
M-1	**82**	**74**	7.9	63	19.4	**82**	0.0
M-12	**82**	**81**	0.4	**81**	0.6	**73**	9.1

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-5	**87**	**83**	5.0	**80**	7.3	**85**	2.3
M-8	**83**	**80**	2.8	**79**	4.2	**78**	4.9
SW1-1	**81**	**81**	0.0	**81**	0.2	**73**	8.5
SW1-2	**79**	**77**	2.2	**76**	3.1	**74**	5.7
SW1-3	**84**	**82**	2.1	**81**	3.0	**79**	5.4
SW1-4	**86**	**82**	4.2	**79**	6.5	**83**	2.3
SW1-5	**80**	**74**	6.0	63	17.5	**80**	0.0
SW1-6	**85**	**78**	6.6	**73**	11.9	**83**	1.9
SW1-7	**81**	**78**	2.8	**76**	4.7	**77**	3.5
SW1-8	**79**	**76**	2.6	**74**	4.6	**75**	3.9
SW2-1	**76**	**74**	2.1	**73**	3.2	**71**	5.6
SW2-2	**77**	**71**	6.2	60	17.7	**77**	0.0
SW2-3	**82**	**74**	7.2	**70**	11.9	**80**	2.0
SW2-4	**75**	**69**	5.5	58	17.0	**75**	0.0
SW2-5	**79**	**73**	6.6	**69**	10.8	**77**	2.5
SW2-6	**81**	**78**	3.1	**75**	5.4	**78**	3.1
SW3-1	**76**	**74**	2.3	**72**	3.9	**72**	3.8
SW3-2	**71**	**66**	5.3	55	16.8	**71**	0.0
SW3-3	**69**	**67**	2.1	56	13.6	**69**	0.0
SW3-4	**76**	**71**	5.5	**68**	8.2	**71**	5.1
SW3-5	**79**	**74**	5.3	**70**	8.5	**75**	3.4
SW3-6	**75**	**72**	3.6	**70**	5.2	**70**	5.0
SW3-7	**77**	**74**	2.8	**72**	4.4	**72**	4.1
SW3-8	**77**	**75**	2.3	**72**	4.6	**74**	3.2
TYEE-Yacht Club	**81**	**81**	0.0	**81**	0.0	**73**	7.9

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table I-2.

[2] – From Scenario 2 (Table I-3).

Table I-5 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**67**	7.7	60	14.5
Good Turn Park	**79**	**72**	7.3	65	14.0
M-1	**82**	**74**	7.9	63	19.4
M-12	**82**	**72**	9.8	**70**	11.9
M-5	**87**	**79**	8.1	**71**	16.4
M-8	**83**	**76**	7.6	**69**	14.3
SW1-1	**81**	**72**	9.0	**70**	11.4
SW1-2	**79**	**71**	8.1	**66**	13.6
SW1-3	**84**	**76**	8.0	**71**	13.6
SW1-4	**86**	**78**	7.3	**70**	15.6
SW1-5	**80**	**74**	6.0	63	17.5
SW1-6	**85**	**77**	7.7	**67**	18.1
SW1-7	**81**	**74**	6.4	**67**	14.2
SW1-8	**79**	**72**	6.3	65	14.1
SW2-1	**76**	**69**	7.4	63	13.5
SW2-2	**77**	**71**	6.2	60	17.7
SW2-3	**82**	**73**	8.5	63	18.6
SW2-4	**75**	**69**	5.5	58	17.0
SW2-5	**79**	**71**	8.2	61	18.1
SW2-6	**81**	**74**	6.3	**66**	14.6
SW3-1	**76**	**70**	6.5	62	13.7
SW3-2	**71**	**66**	5.3	55	16.8
SW3-3	**69**	**67**	2.1	56	13.6
SW3-4	**76**	**68**	8.2	60	16.9
SW3-5	**79**	**71**	7.6	62	16.7
SW3-6	**75**	**68**	7.7	60	15.0
SW3-7	**77**	**70**	7.0	62	14.2

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW3-8	**77**	**71**	5.5	63	13.8
TYEE-Yacht Club	**81**	**73**	8.2	**70**	11.1

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table I-2.

[2] – From Scenario 2 (Table I-3).

Table I-6: Comparison of Total Additional Noise Reduction Provided by Carsonite Composite Panels Absorptive Materials (SW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**71**	3.0	**71**	3.7	**72**	2.0
Good Turn Park	**79**	**76**	2.5	**76**	3.2	**77**	1.9
M-1	**82**	**74**	7.9	**71**	10.9	**82**	0.0
M-12	**82**	**81**	0.4	**81**	0.5	**79**	2.8
M-5	**87**	**83**	5.0	**81**	6.0	**86**	1.1
M-8	**83**	**80**	2.8	**80**	3.5	**81**	2.0
SW1-1	**81**	**81**	0.0	**81**	0.1	**79**	2.7
SW1-2	**79**	**77**	2.2	**77**	2.6	**77**	2.2
SW1-3	**84**	**82**	2.1	**82**	2.6	**82**	2.1
SW1-4	**86**	**82**	4.2	**80**	5.2	**85**	1.1
SW1-5	**80**	**74**	6.0	**71**	9.0	**80**	0.0
SW1-6	**85**	**78**	6.6	**76**	8.7	**84**	0.9
SW1-7	**81**	**78**	2.8	**77**	3.7	**79**	1.5
SW1-8	**79**	**76**	2.6	**75**	3.6	**77**	1.7
SW2-1	**76**	**74**	2.1	**74**	2.6	**74**	2.1
SW2-2	**77**	**71**	6.2	**68**	9.2	**77**	0.0
SW2-3	**82**	**74**	7.2	**73**	9.1	**81**	1.0
SW2-4	**75**	**69**	5.5	**66**	8.5	**75**	0.0
SW2-5	**79**	**73**	6.6	**71**	8.4	**78**	1.2
SW2-6	**81**	**78**	3.1	**76**	4.2	**79**	1.4
SW3-1	**76**	**74**	2.3	**73**	3.1	**74**	1.6
SW3-2	**71**	**66**	5.3	63	8.3	**71**	0.0
SW3-3	**69**	**67**	2.1	64	5.1	**69**	0.0
SW3-4	**76**	**71**	5.5	**70**	6.7	**74**	2.0
SW3-5	**79**	**74**	5.3	**72**	6.7	**77**	1.5
SW3-6	**75**	**72**	3.6	**71**	4.3	**73**	2.0
SW3-7	**77**	**74**	2.8	**73**	3.6	**75**	1.7

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW3-8	**77**	**75**	2.3	**73**	3.4	**75**	1.4
TYEE-Yacht Club	**81**	**81**	0.0	**81**	0.0	**78**	2.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

1 – From Table I-2.

2 – From Scenario 2 (Table I-3).

Table I-6 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**70**	4.9	**68**	6.0
Good Turn Park	**79**	**75**	4.5	**73**	5.5
M-1	**82**	**74**	7.9	**71**	10.9
M-12	**82**	**78**	3.2	**78**	3.4
M-5	**87**	**81**	6.4	**80**	8.0
M-8	**83**	**79**	4.8	**77**	5.9
SW1-1	**81**	**79**	2.7	**78**	3.0
SW1-2	**79**	**75**	4.4	**74**	5.2
SW1-3	**84**	**80**	4.3	**79**	5.1
SW1-4	**86**	**80**	5.6	**79**	7.2
SW1-5	**80**	**74**	6.0	**71**	9.0
SW1-6	**85**	**78**	7.1	**75**	9.6
SW1-7	**81**	**77**	4.3	**75**	5.8
SW1-8	**79**	**75**	4.2	**73**	5.7
SW2-1	**76**	**72**	4.2	**71**	5.1
SW2-2	**77**	**71**	6.2	**68**	9.2

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW2-3	**82**	**74**	7.9	**71**	10.2
SW2-4	**75**	**69**	5.5	**66**	8.5
SW2-5	**79**	**72**	7.4	**70**	9.6
SW2-6	**81**	**76**	4.5	**75**	6.1
SW3-1	**76**	**72**	4.0	**71**	5.3
SW3-2	**71**	**66**	5.3	63	8.3
SW3-3	**69**	**67**	2.1	64	5.1
SW3-4	**76**	**70**	6.7	**68**	8.5
SW3-5	**79**	**72**	6.4	**71**	8.3
SW3-6	**75**	**70**	5.3	**69**	6.6
SW3-7	**77**	**72**	4.5	**71**	5.8
SW3-8	**77**	**73**	3.7	**72**	5.3
TYEE-Yacht Club	**81**	**79**	2.3	**78**	2.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table I-2.

[2] – From Scenario 2 (Table I-3).

Table I-7: Comparison of Total Additional Noise Reduction Provided by NoiseShield Type FS Absorptive Materials (SW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**71**	3.0	**70**	4.3	**70**	4.9
Good Turn Park	**79**	**76**	2.5	**75**	3.8	**74**	4.6
M-1	**82**	**74**	7.9	63	18.9	**82**	0.0
M-12	**82**	**81**	0.4	**81**	0.6	**73**	8.9
M-5	**87**	**83**	5.0	**80**	7.2	**85**	2.2
M-8	**83**	**80**	2.8	**79**	4.2	**79**	4.8
SW1-1	**81**	**81**	0.0	**81**	0.2	**73**	8.3
SW1-2	**79**	**77**	2.2	**76**	3.1	**74**	5.6
SW1-3	**84**	**82**	2.1	**81**	3.0	**79**	5.3
SW1-4	**86**	**82**	4.2	**79**	6.4	**83**	2.2
SW1-5	**80**	**74**	6.0	63	17.0	**80**	0.0
SW1-6	**85**	**78**	6.6	**73**	11.8	**83**	1.9
SW1-7	**81**	**78**	2.8	**76**	4.7	**77**	3.4
SW1-8	**79**	**76**	2.6	**74**	4.6	**75**	3.8
SW2-1	**76**	**74**	2.1	**73**	3.2	**71**	5.5
SW2-2	**77**	**71**	6.2	60	17.2	**77**	0.0
SW2-3	**82**	**74**	7.2	**70**	11.9	**80**	2.0
SW2-4	**75**	**69**	5.5	58	16.5	**75**	0.0
SW2-5	**79**	**73**	6.6	**69**	10.7	**77**	2.5
SW2-6	**81**	**78**	3.1	**75**	5.4	**78**	3.0
SW3-1	**76**	**74**	2.3	**72**	3.9	**72**	3.7
SW3-2	**71**	**66**	5.3	55	16.3	**71**	0.0
SW3-3	**69**	**67**	2.1	56	13.1	**69**	0.0
SW3-4	**76**	**71**	5.5	**68**	8.2	**71**	5.0
SW3-5	**79**	**74**	5.3	**70**	8.4	**75**	3.4
SW3-6	**75**	**72**	3.6	**70**	5.2	**70**	4.9
SW3-7	**77**	**74**	2.8	**72**	4.4	**73**	4.0

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW3-8	**77**	**75**	2.3	**72**	4.6	**74**	3.1
TYEE-Yacht Club	**81**	**81**	0.0	**81**	0.0	**73**	7.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table I-2.

[2] – From Scenario 2 (Table I-3).

Table I-7 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
Fairview Park	**74**	**67**	7.7	60	14.0
Good Turn Park	**79**	**72**	7.2	65	13.6
M-1	**82**	**74**	7.9	63	18.9
M-12	**82**	**72**	9.5	**70**	11.5
M-5	**87**	**79**	8.1	**72**	16.0
M-8	**83**	**76**	7.5	**69**	13.9
SW1-1	**81**	**73**	8.7	**70**	11.0
SW1-2	**79**	**71**	8.0	**66**	13.2
SW1-3	**84**	**76**	7.9	**71**	13.1
SW1-4	**86**	**78**	7.3	**71**	15.2
SW1-5	**80**	**74**	6.0	63	17.0
SW1-6	**85**	**77**	7.7	**67**	17.6
SW1-7	**81**	**75**	6.4	**67**	13.8
SW1-8	**79**	**73**	6.3	65	13.7
SW2-1	**76**	**69**	7.3	63	13.1
SW2-2	**77**	**71**	6.2	60	17.2

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SW2-3	**82**	**73**	8.5	63	18.2
SW2-4	**75**	**69**	5.5	58	16.5
SW2-5	**79**	**71**	8.2	62	17.6
SW2-6	**81**	**74**	6.2	**67**	14.1
SW3-1	**76**	**70**	6.4	63	13.3
SW3-2	**71**	**66**	5.3	55	16.3
SW3-3	**69**	**67**	2.1	56	13.1
SW3-4	**76**	**68**	8.2	60	16.5
SW3-5	**79**	**71**	7.6	63	16.3
SW3-6	**75**	**68**	7.7	61	14.6
SW3-7	**77**	**70**	6.9	63	13.8
SW3-8	**77**	**71**	5.4	64	13.3
TYEE-Yacht Club	**81**	**73**	8.0	**70**	10.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table I-2.

[2] – From Scenario 2 (Table I-3).

APPENDIX J: Southeast Quadrant Noise Level Results

Table J-1: Existing (2004) Modeled Traffic Noise Levels (SE Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq}	Households	Type[1]
M-19	**68**	**79**	**80**	10	MF
M-2	**77**	N/A	**77**	1	SF
M-4	**77**	**75**	**79**	3	SF
M-7	**77**	**77**	**80**	1	SF
SE1-1	**67**	**75**	**76**	4	MF
SE1-10	**70**	**74**	**75**	33	MF
SE1-11	**74**	**74**	**77**	11	MF
SE1-12	**75**	**75**	**78**	10	SF
SE1-13	**77**	**76**	**80**	22	MF
SE1-14	**77**	N/A	**77**	7	SF
SE1-2	**71**	**75**	**77**	1	C
SE1-3	**73**	**75**	**77**	17	MF
SE1-4	**76**	**76**	**79**	1	SF
SE1-5	**78**	N/A	**78**	1	SF
SE1-6	65	**79**	**79**	1	P
SE1-7	**68**	**76**	**77**	10	MF
SE1-8	**69**	**78**	**79**	36	MF
SE1-9	**71**	**77**	**78**	4	MF
SE2-1	**74**	**73**	**77**	4	SF
SE2-10	**72**	**71**	**75**	4	SF
SE2-11	**72**	**73**	**75**	4	SF
SE2-12	**68**	N/A	**68**	7	SF
SE2-2	**68**	**72**	**73**	2	SF
SE2-3	**68**	**73**	**74**	6	SF
SE2-4	**73**	**74**	**76**	5	SF
SE2-5	**72**	**73**	**75**	12	MF
SE2-6	**71**	**72**	**74**	12	MF
SE2-7	**73**	**73**	**76**	5	SF
SE2-8	**72**	**71**	**75**	5	SF
SE2-9	**73**	**70**	**75**	3	SF
SE3-1	**73**	**73**	**76**	3	SF
SE3-2	**69**	**70**	**73**	28	MF
SE3-3	**70**	**70**	**73**	14	SF
SE3-4	**70**	**70**	**73**	7	SF
SE3-5	**69**	**69**	**72**	4	SF
SE3-6	**67**	N/A	**67**	3	SF
SE3-7	64	N/A	64	8	SF
SE4-1	**66**	**69**	**71**	5	SF
SE4-10	63	59	64	8	SF
SE4-2	64	**69**	**70**	6	SF
SE4-3	65	**69**	**70**	3	SF
SE4-3	64	**68**	**70**	4	SF
SE4-4	65	**68**	**70**	3	SF

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq}	Households	Type[1]
SE4-5	62	**68**	**69**	4	SF
SE4-6	**70**	**70**	**73**	12	MF
SE4-7	**69**	**69**	**72**	2	SF
SE4-8	**69**	**68**	**72**	5	SF
SE4-9	**68**	**68**	**71**	3	SF
SE5-1	**70**	**71**	**73**	4	SF
SE5-2	**67**	**71**	**72**	3	SF
SE5-3	**66**	**70**	**71**	3	SF

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility.

Table J-2: 1999 Modeled Traffic Noise Levels (SE Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
M-19	**73**	**83**	**83**	10	MF
M-2	**81**	N/A	**81**	1	SF
M-4	**79**	**75**	**80**	3	SF
M-7	**78**	**80**	**82**	1	SF
SE1-1	**73**	**79**	**80**	4	MF
SE1-10	**75**	**77**	**79**	33	MF
SE1-11	**78**	**76**	**80**	11	MF
SE1-12	**77**	**78**	**81**	10	SF
SE1-13	**78**	**79**	**82**	22	MF
SE1-14	**82**	N/A	**82**	7	SF
SE1-2	**77**	**78**	**81**	1	C
SE1-3	**78**	**79**	**82**	17	MF
SE1-4	**77**	**79**	**81**	1	SF
SE1-5	**83**	N/A	**83**	1	SF
SE1-6	**69**	**82**	**82**	1	P
SE1-7	**75**	**79**	**80**	10	MF
SE1-8	**74**	**82**	**83**	36	MF
SE1-9	**76**	**80**	**81**	4	MF
SE2-1	**77**	**77**	**80**	4	SF
SE2-10	**76**	**75**	**79**	4	SF
SE2-11	**73**	**75**	**77**	4	SF
SE2-12	**73**	N/A	**73**	7	SF
SE2-2	**71**	**73**	**75**	2	SF
SE2-3	**73**	**76**	**78**	6	SF
SE2-4	**78**	**77**	**81**	5	SF
SE2-5	**77**	**76**	**80**	12	MF
SE2-6	**75**	**75**	**78**	12	MF
SE2-7	**77**	**76**	**80**	5	SF
SE2-8	**76**	**75**	**79**	5	SF
SE2-9	**76**	**73**	**78**	3	SF
SE3-1	**75**	**76**	**79**	3	SF
SE3-2	**73**	**74**	**77**	28	MF
SE3-3	**74**	**73**	**77**	14	SF

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
SE3-4	**74**	**74**	**77**	7	SF
SE3-5	**73**	**72**	**76**	4	SF
SE3-6	**71**	N/A	**71**	3	SF
SE3-7	**68**	N/A	**68**	8	SF
SE4-1	**71**	**72**	**75**	5	SF
SE4-10	**66**	62	**67**	8	SF
SE4-2	**69**	**72**	**74**	6	SF
SE4-3	**70**	**72**	**74**	3	SF
SE4-4	**69**	**71**	**73**	4	SF
SE4-5	**67**	**71**	**72**	4	SF
SE4-6	**74**	**73**	**77**	12	MF
SE4-7	**73**	**72**	**76**	2	SF
SE4-8	**72**	**71**	**75**	5	SF
SE4-9	**72**	**71**	**75**	3	SF
SE5-1	**72**	**73**	**76**	4	SF
SE5-2	**70**	**73**	**75**	3	SF
SE5-3	**69**	**71**	**73**	3	SF

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility.

Table J-3: Total Noise Reduction Provided With and Without an At-Grade Noise Wall (SE Quadrant)

Site	1999 No Wall[1] (dBA)	Scenario 1			
		Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
M-19	**83**	**72**	**82**	**82**	1.0
M-2	**81**	**78**	N/A	**78**	3.0
M-4	**80**	**71**	**67**	**72**	8.0
M-7	**82**	**71**	**71**	**74**	8.1
SE1-1 (Apptmts +Boat Hse)	**80**	**71**	**77**	**78**	2.0
SE1-10	**79**	**73**	**75**	**77**	2.0
SE1-11	**80**	**75**	**76**	**79**	1.6
SE1-12	**81**	**72**	**77**	**78**	2.3
SE1-13	**82**	**72**	**74**	**76**	5.4
SE1-14	**82**	**74**	N/A	**74**	8.0
SE1-2	**81**	**74**	**75**	**78**	3.0
SE1-3	**82**	**75**	**77**	**79**	2.4
SE1-4	**81**	**71**	**73**	**75**	6.0
SE1-5	**83**	**74**	N/A	**74**	9.0
SE1-6 (Park)	**82**	**68**	**82**	**82**	0.0
SE1-7	**80**	**72**	**77**	**78**	2.3
SE1-8	**83**	**73**	**80**	**81**	1.8
SE1-9	**81**	**73**	**77**	**78**	3.0
SE2-1	**80**	**75**	**74**	**78**	2.5
SE2-10	**79**	**74**	**72**	**76**	2.4
SE2-11	**77**	**67**	**70**	**72**	5.4
SE2-12	**73**	**66**	N/A	**66**	7.0
SE2-2	**75**	65	**68**	**70**	5.4
SE2-3	**78**	**71**	**74**	**76**	2.0
SE2-4	**81**	**75**	**75**	**78**	2.5
SE2-5	**80**	**74**	**74**	**77**	2.5
SE2-6	**78**	**72**	**73**	**76**	2.5
SE2-7	**80**	**74**	**73**	**77**	3.0
SE2-8	**79**	**74**	**72**	**76**	2.4
SE2-9	**78**	**74**	**72**	**76**	1.6
SE3-1	**79**	**71**	**74**	**76**	2.8
SE3-2	**77**	**71**	**71**	**74**	2.5

Site	1999 No Wall[1] (dBA)	Scenario 1 Direct Path With Wall (dBA)	Scenario 1 Reflected Path With Wall (dBA)	Scenario 1 Combined Noise (dBA)	Scenario 1 Noise Reduction
SE3-3	**77**	**72**	**71**	**75**	2.0
SE3-4	**77**	**72**	**71**	**75**	2.5
SE3-5	**76**	**71**	**70**	**74**	2.0
SE3-6	**71**	61	N/A	61	10.0
SE3-7	**68**	63	N/A	63	5.0
SE4-1	**75**	**69**	**70**	**73**	2.0
SE4-10	**67**	65	61	**66**	1.0
SE4-2	**74**	**68**	**70**	**72**	1.6
SE4-3	**74**	**68**	**70**	**72**	2.0
SE4-4	**73**	**67**	**69**	**71**	2.0
SE4-5	**72**	**66**	**69**	**71**	1.7
SE4-6	**77**	**72**	**70**	**74**	2.4
SE4-7	**76**	**71**	**70**	**74**	2.0
SE4-8	**75**	**70**	**69**	**73**	2.0
SE4-9	**75**	**70**	**69**	**73**	2.0
SE5-1	**76**	**71**	**70**	**74**	2.0
SE5-2	**75**	65	**69**	**70**	4.3
SE5-3	**73**	64	**67**	**69**	4.4
Total Reductions Greater Than Scenario 2:					**25**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

1 – From Table J-2.

Table J-3 Cont'd

Site	1999 No Wall[1] (dBA)	Scenario 2			
		Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
M-19	**83**	**72**	**82**	**82**	0.6
M-2	**81**	**79**	**71**	**80**	1.4
M-4	**80**	**75**	**72**	**77**	3.2
M-7	**82**	**75**	**77**	**79**	2.9
SE1-1 (Apptmts +Boat Hse)	**80**	**71**	**77**	**78**	2.0
SE1-10	**79**	**73**	**75**	**77**	1.9
SE1-11	**80**	**75**	**76**	**79**	1.5
SE1-12	**81**	**74**	**77**	**79**	2.2
SE1-13	**82**	**75**	**77**	**79**	2.9
SE1-14	**82**	**75**	**68**	**76**	6.2
SE1-2	**81**	**74**	**75**	**78**	3.5
SE1-3	**82**	**75**	**77**	**79**	2.9
SE1-4	**81**	**74**	**77**	**79**	2.2
SE1-5	**83**	**77**	**71**	**78**	5.0
SE1-6 (Park)	**82**	**68**	**82**	**82**	-0.2
SE1-7	**80**	**72**	**77**	**78**	1.8
SE1-8	**83**	**73**	**80**	**81**	2.2
SE1-9	**81**	**73**	**78**	**79**	1.8
SE2-1	**80**	**75**	**75**	**78**	2.0
SE2-10	**79**	**74**	**73**	**77**	2.5
SE2-11	**77**	**70**	**72**	**74**	2.9
SE2-12	**73**	**67**	58	**68**	5.5
SE2-2	**75**	**68**	**71**	**73**	2.2
SE2-3	**78**	**71**	**74**	**76**	2.2
SE2-4	**81**	**75**	**75**	**78**	3.0
SE2-5	**80**	**74**	**74**	**77**	3.0
SE2-6	**78**	**72**	**73**	**76**	2.5
SE2-7	**80**	**75**	**74**	**78**	2.5
SE2-8	**79**	**74**	**72**	**76**	2.9
SE2-9	**78**	**74**	**73**	**77**	1.5
SE3-1	**79**	**73**	**75**	**77**	1.9
SE3-2	**77**	**71**	**72**	**75**	2.5
SE3-3	**77**	**72**	**71**	**75**	2.5

Site	1999 No Wall[1] (dBA)	Scenario 2			
		Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
SE3-4	**77**	**72**	**71**	**75**	2.5
SE3-5	**76**	**71**	**70**	**74**	2.5
SE3-6	**71**	**66**	55	**66**	4.7
SE3-7	**68**	64	58	65	3.0
SE4-1	**75**	**69**	**70**	**73**	2.5
SE4-10	**67**	65	61	**66**	0.5
SE4-2	**74**	**67**	**70**	**72**	2.2
SE4-3	**74**	**68**	**70**	**72**	1.9
SE4-4	**73**	**67**	**69**	**71**	1.9
SE4-5	**72**	65	**69**	**70**	1.5
SE4-6	**77**	**72**	**71**	**75**	2.5
SE4-7	**76**	**71**	**70**	**74**	2.5
SE4-8	**75**	**71**	**70**	**74**	1.5
SE4-9	**75**	**70**	**69**	**73**	2.5
SE5-1	**76**	**71**	**71**	**74**	2.0
SE5-2	**75**	**67**	**70**	**72**	3.2
SE5-3	**73**	**66**	**69**	**71**	2.2
Total Reductions Greater Than Scenario 1:					**2**

Table J-4: Comparison of Total Additional Noise Reduction Provided by Acoustax/Silent Screen Absorptive Materials (SE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**82**	1.0	**82**	1.4	**75**	8.1
M-2	**81**	**79**	2.0	**68**	13.5	**81**	0.0
M-4	**80**	**77**	3.7	**73**	7.9	**79**	1.3
M-7	**82**	**79**	3.0	**77**	4.9	**78**	3.7
SE1-1	**80**	**78**	2.0	**77**	2.9	**74**	5.9
SE1-10	**79**	**77**	2.0	**75**	3.9	**75**	3.7
SE1-11	**80**	**79**	1.6	**76**	3.9	**78**	1.9
SE1-12	**81**	**79**	1.8	**77**	3.4	**77**	3.2
SE1-13	**82**	**79**	2.4	**77**	4.3	**78**	3.2
SE1-14	**82**	**75**	7.0	64	18.5	**82**	0.0
SE1-2	**81**	**78**	3.0	**75**	5.3	**77**	3.2
SE1-3	**82**	**79**	2.4	**77**	4.3	**78**	3.2
SE1-4	**81**	**79**	2.4	**77**	4.0	**77**	3.7
SE1-5	**83**	**77**	6.0	**66**	17.5	**83**	0.0
SE1-6 (Park)	**82**	**82**	0.0	**82**	0.2	**73**	9.4
SE1-7	**80**	**78**	2.3	**77**	3.4	**76**	4.7
SE1-8	**83**	**81**	1.8	**80**	2.6	**76**	7.0
SE1-9	**81**	**79**	2.3	**78**	3.4	**77**	4.7
SE2-1	**80**	**78**	2.0	**75**	4.7	**77**	2.7
SE2-10	**79**	**77**	2.0	**73**	5.2	**76**	2.3
SE2-11	**77**	**74**	3.0	**72**	4.9	**73**	3.7
SE2-12	**73**	**67**	6.0	56	17.5	**73**	0.0
SE2-2	**75**	**73**	2.4	**71**	4.0	**71**	3.7
SE2-3	**78**	**76**	2.0	**74**	3.6	**74**	4.2
SE2-4	**81**	**78**	2.5	**75**	5.2	**78**	2.3
SE2-5	**80**	**77**	2.5	**74**	5.2	**77**	2.3
SE2-6	**78**	**76**	2.5	**73**	4.8	**75**	2.7
SE2-7	**80**	**78**	2.0	**74**	5.2	**77**	2.3

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-8	**79**	**76**	2.4	**72**	6.1	**76**	2.3
SE2-9	**78**	**77**	1.2	**73**	4.4	**76**	1.6
SE3-1	**79**	**77**	1.4	**75**	3.3	**75**	3.2
SE3-2	**77**	**75**	2.0	**72**	4.3	**73**	3.2
SE3-3	**77**	**75**	2.0	**71**	5.2	**74**	2.3
SE3-4	**77**	**75**	2.5	**71**	5.6	**74**	2.7
SE3-5	**76**	**74**	2.0	**70**	5.2	**73**	2.3
SE3-6	**71**	**66**	5.0	55	16.5	**71**	0.0
SE3-7	**68**	64	4.0	53	15.5	**68**	0.0
SE4-1	**75**	**73**	2.0	**70**	4.3	**71**	3.2
SE4-10	**67**	**66**	1.0	62	5.7	**66**	1.3
SE4-2	**74**	**72**	2.0	**70**	3.6	**70**	4.2
SE4-3	**74**	**72**	2.0	**70**	3.9	**70**	3.7
SE4-4	**73**	**71**	2.0	**69**	3.9	**69**	3.7
SE4-5	**72**	**70**	2.0	**69**	3.3	**68**	4.7
SE4-6	**77**	**75**	2.0	**71**	5.2	**74**	2.3
SE4-7	**76**	**74**	2.0	**70**	5.2	**73**	2.3
SE4-8	**75**	**74**	1.0	**70**	4.2	**72**	2.3
SE4-9	**75**	**73**	2.0	**69**	5.2	**72**	2.3
SE5-1	**76**	**74**	1.5	**71**	4.2	**72**	3.2
SE5-2	**75**	**72**	3.0	**70**	4.6	**71**	4.2
SE5-3	**73**	**71**	2.4	**69**	4.0	**69**	3.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

Table J-4 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Absorptive Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**74**	9.1	**71**	12.5
M-2	**81**	**79**	2.0	**68**	13.5
M-4	**80**	**75**	5.3	65	15.2
M-7	**82**	**75**	6.7	**68**	14.5
SE1-1	**80**	**72**	7.9	**67**	13.5
SE1-10	**79**	**73**	5.7	**66**	13.5
SE1-11	**80**	**75**	4.8	**67**	13.0
SE1-12	**81**	**75**	6.0	**67**	13.2
SE1-13	**82**	**75**	6.1	**68**	13.9
SE1-14	**82**	**75**	7.0	64	18.5
SE1-2	**81**	**74**	6.2	**66**	14.5
SE1-3	**82**	**75**	6.1	**68**	13.9
SE1-4	**81**	**75**	6.5	**67**	13.8
SE1-5	**83**	**77**	6.0	**66**	17.5
SE1-6 (Park)	**82**	**72**	9.7	**71**	11.5
SE1-7	**80**	**73**	7.6	**67**	13.7
SE1-8	**83**	**74**	8.3	**69**	13.3
SE1-9	**81**	**74**	7.6	**68**	13.7
SE2-1	**80**	**75**	4.7	**67**	13.5
SE2-10	**79**	**74**	4.3	65	13.5
SE2-11	**77**	**70**	6.7	63	14.5
SE2-12	**73**	**67**	6.0	56	17.5
SE2-2	**75**	**69**	6.5	61	13.8
SE2-3	**78**	**72**	6.2	64	13.5
SE2-4	**81**	**75**	5.2	**67**	14.0

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Absorptive Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-5	**80**	**74**	5.2	**66**	14.0
SE2-6	**78**	**72**	5.6	64	13.9
SE2-7	**80**	**75**	4.3	**66**	13.5
SE2-8	**79**	**74**	4.3	65	13.9
SE2-9	**78**	**74**	3.5	65	12.7
SE3-1	**79**	**73**	5.1	**66**	12.9
SE3-2	**77**	**71**	5.2	63	13.5
SE3-3	**77**	**72**	4.3	63	13.5
SE3-4	**77**	**72**	4.8	63	13.9
SE3-5	**76**	**71**	4.3	62	13.5
SE3-6	**71**	**66**	5.0	55	16.5
SE3-7	**68**	64	4.0	53	15.5
SE4-1	**75**	**69**	5.2	61	13.5
SE4-10	**67**	65	2.3	55	12.5
SE4-2	**74**	**68**	6.2	60	13.5
SE4-3	**74**	**68**	5.7	61	13.5
SE4-4	**73**	**67**	5.7	60	13.5
SE4-5	**72**	**66**	6.7	59	13.5
SE4-6	**77**	**72**	4.3	63	13.5
SE4-7	**76**	**71**	4.3	62	13.5
SE4-8	**75**	**71**	3.3	62	12.5
SE4-9	**75**	**70**	4.3	61	13.5
SE5-1	**76**	**71**	4.2	63	13.0
SE5-2	**75**	**68**	7.2	60	14.5
SE5-3	**73**	**67**	6.5	59	13.8

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

Table J-5: Comparison of Total Additional Noise Reduction Provided by Sound Fighter Systems Absorptive Materials (SE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**82**	1.0	**82**	1.4	**75**	8.0
M-2	**81**	**79**	2.0	**68**	13.2	**81**	0.0
M-4	**80**	**77**	3.7	**73**	7.8	**79**	1.3
M-7	**82**	**79**	3.0	**77**	4.9	**78**	3.6
SE1-1	**80**	**78**	2.0	**77**	2.9	**74**	5.8
SE1-10	**79**	**77**	2.0	**75**	3.9	**75**	3.6
SE1-11	**80**	**79**	1.6	**76**	3.9	**78**	1.9
SE1-12	**81**	**79**	1.8	**77**	3.4	**77**	3.1
SE1-13	**82**	**79**	2.4	**77**	4.3	**78**	3.1
SE1-14	**82**	**75**	7.0	64	18.2	**82**	0.0
SE1-2	**81**	**78**	3.0	**75**	5.3	**77**	3.1
SE1-3	**82**	**79**	2.4	**77**	4.3	**78**	3.1
SE1-4	**81**	**79**	2.4	**77**	4.0	**77**	3.6
SE1-5	**83**	**77**	6.0	**66**	17.2	**83**	0.0
SE1-6 (Park)	**82**	**82**	0.0	**82**	0.2	**73**	9.2
SE1-7	**80**	**78**	2.3	**77**	3.4	**76**	4.7
SE1-8	**83**	**81**	1.8	**80**	2.6	**76**	7.0
SE1-9	**81**	**79**	2.3	**78**	3.4	**77**	4.7
SE2-1	**80**	**78**	2.0	**75**	4.7	**77**	2.7
SE2-10	**79**	**77**	2.0	**73**	5.1	**76**	2.3
SE2-11	**77**	**74**	3.0	**72**	4.9	**73**	3.6
SE2-12	**73**	**67**	6.0	56	17.2	**73**	0.0
SE2-2	**75**	**73**	2.4	**71**	4.0	**71**	3.6
SE2-3	**78**	**76**	2.0	**74**	3.6	**74**	4.2
SE2-4	**81**	**78**	2.5	**75**	5.2	**78**	2.3
SE2-5	**80**	**77**	2.5	**74**	5.2	**77**	2.3
SE2-6	**78**	**76**	2.5	**73**	4.8	**75**	2.7

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-7	**80**	**78**	2.0	**74**	5.1	**77**	2.3
SE2-8	**79**	**76**	2.4	**72**	6.1	**76**	2.3
SE2-9	**78**	**77**	1.2	**73**	4.4	**76**	1.6
SE3-1	**79**	**77**	1.4	**75**	3.3	**75**	3.1
SE3-2	**77**	**75**	2.0	**72**	4.3	**73**	3.1
SE3-3	**77**	**75**	2.0	**71**	5.1	**74**	2.3
SE3-4	**77**	**75**	2.5	**71**	5.6	**74**	2.7
SE3-5	**76**	**74**	2.0	**70**	5.1	**73**	2.3
SE3-6	**71**	**66**	5.0	55	16.2	**71**	0.0
SE3-7	**68**	64	4.0	53	15.2	**68**	0.0
SE4-1	**75**	**73**	2.0	**70**	4.3	**71**	3.1
SE4-10	**67**	**66**	1.0	62	5.7	**66**	1.3
SE4-2	**74**	**72**	2.0	**70**	3.6	**70**	4.2
SE4-3	**74**	**72**	2.0	**70**	3.9	**70**	3.6
SE4-4	**73**	**71**	2.0	**69**	3.9	**69**	3.6
SE4-5	**72**	**70**	2.0	**69**	3.3	**68**	4.7
SE4-6	**77**	**75**	2.0	**71**	5.1	**74**	2.3
SE4-7	**76**	**74**	2.0	**70**	5.1	**73**	2.3
SE4-8	**75**	**74**	1.0	**70**	4.1	**72**	2.3
SE4-9	**75**	**73**	2.0	**69**	5.1	**72**	2.3
SE5-1	**76**	**74**	1.5	**71**	4.2	**72**	3.1
SE5-2	**75**	**72**	3.0	**70**	4.6	**71**	4.2
SE5-3	**73**	**71**	2.4	**69**	4.0	**69**	3.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

1 – From Table J-2.

2 – From Scenario 1 (Table J-3).

Table J-5 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**74**	9.0	**71**	12.2
M-2	**81**	**79**	2.0	**68**	13.2
M-4	**80**	**75**	5.3	**66**	14.9
M-7	**82**	**75**	6.6	**68**	14.2
SE1-1	**80**	**72**	7.8	**67**	13.2
SE1-10	**79**	**73**	5.6	**66**	13.2
SE1-11	**80**	**75**	4.7	**67**	12.8
SE1-12	**81**	**75**	5.9	**68**	13.0
SE1-13	**82**	**75**	6.1	**68**	13.7
SE1-14	**82**	**75**	7.0	64	18.2
SE1-2	**81**	**74**	6.1	**66**	14.2
SE1-3	**82**	**75**	6.1	**68**	13.7
SE1-4	**81**	**75**	6.5	**68**	13.6
SE1-5	**83**	**77**	6.0	**66**	17.2
SE1-6 (Park)	**82**	**73**	9.6	**71**	11.3
SE1-7	**80**	**73**	7.5	**67**	13.5
SE1-8	**83**	**74**	8.3	**70**	13.1
SE1-9	**81**	**74**	7.5	**68**	13.5
SE2-1	**80**	**75**	4.7	**67**	13.2
SE2-10	**79**	**74**	4.3	65	13.2
SE2-11	**77**	**70**	6.6	63	14.2
SE2-12	**73**	**67**	6.0	56	17.2
SE2-2	**75**	**69**	6.5	62	13.6
SE2-3	**78**	**72**	6.2	65	13.2
SE2-4	**81**	**75**	5.2	**67**	13.8
SE2-5	**80**	**74**	5.2	**66**	13.8

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-6	**78**	**72**	5.6	64	13.7
SE2-7	**80**	**75**	4.3	**66**	13.2
SE2-8	**79**	**74**	4.3	65	13.7
SE2-9	**78**	**74**	3.5	65	12.5
SE3-1	**79**	**73**	5.1	**66**	12.7
SE3-2	**77**	**71**	5.1	63	13.2
SE3-3	**77**	**72**	4.3	63	13.2
SE3-4	**77**	**72**	4.8	63	13.7
SE3-5	**76**	**71**	4.3	62	13.2
SE3-6	**71**	**66**	5.0	55	16.2
SE3-7	**68**	64	4.0	53	15.2
SE4-1	**75**	**69**	5.1	61	13.2
SE4-10	**67**	65	2.3	55	12.2
SE4-2	**74**	**68**	6.2	61	13.2
SE4-3	**74**	**68**	5.6	61	13.2
SE4-4	**73**	**67**	5.6	60	13.2
SE4-5	**72**	**66**	6.7	59	13.2
SE4-6	**77**	**72**	4.3	63	13.2
SE4-7	**76**	**71**	4.3	62	13.2
SE4-8	**75**	**71**	3.3	62	12.2
SE4-9	**75**	**70**	4.3	61	13.2
SE5-1	**76**	**71**	4.2	63	12.8
SE5-2	**75**	**68**	7.2	61	14.2
SE5-3	**73**	**67**	6.5	60	13.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

Table J-6: Comparison of Total Additional Noise Reduction Provided by Carsonite Composite Panels Absorptive Materials (SE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**82**	1.0	**82**	1.2	**81**	2.6
M-2	**81**	**79**	2.0	**76**	5.0	**81**	0.0
M-4	**80**	**77**	3.7	**75**	5.5	**80**	0.7
M-7	**82**	**79**	3.0	**78**	3.9	**81**	1.6
SE1-1	**80**	**78**	2.0	**78**	2.5	**78**	2.2
SE1-10	**79**	**77**	2.0	**76**	2.9	**78**	1.6
SE1-11	**80**	**79**	1.6	**77**	2.7	**79**	0.9
SE1-12	**81**	**79**	1.8	**78**	2.6	**79**	1.4
SE1-13	**82**	**79**	2.4	**78**	3.3	**80**	1.4
SE1-14	**82**	**75**	7.0	**72**	10.0	**82**	0.0
SE1-2	**81**	**78**	3.0	**76**	4.1	**79**	1.4
SE1-3	**82**	**79**	2.4	**78**	3.3	**80**	1.4
SE1-4	**81**	**79**	2.4	**78**	3.2	**80**	1.6
SE1-5	**83**	**77**	6.0	**74**	9.0	**83**	0.0
SE1-6 (Park)	**82**	**82**	0.0	**82**	0.1	**79**	2.8
SE1-7	**80**	**78**	2.3	**78**	2.8	**79**	1.9
SE1-8	**83**	**81**	1.8	**80**	2.2	**80**	2.5
SE1-9	**81**	**79**	2.3	**79**	2.8	**80**	1.9
SE2-1	**80**	**78**	2.0	**77**	3.2	**79**	1.2
SE2-10	**79**	**77**	2.0	**75**	3.4	**77**	1.1
SE2-11	**77**	**74**	3.0	**73**	3.9	**76**	1.6
SE2-12	**73**	**67**	6.0	64	9.0	**73**	0.0
SE2-2	**75**	**73**	2.4	**72**	3.2	**74**	1.6
SE2-3	**78**	**76**	2.0	**75**	2.8	**76**	1.8
SE2-4	**81**	**78**	2.5	**77**	3.8	**79**	1.1
SE2-5	**80**	**77**	2.5	**76**	3.8	**78**	1.1

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-6	**78**	**76**	2.5	**74**	3.6	**77**	1.2
SE2-7	**80**	**78**	2.0	**76**	3.4	**78**	1.1
SE2-8	**79**	**76**	2.4	**75**	4.0	**77**	1.1
SE2-9	**78**	**77**	1.2	**75**	2.6	**77**	0.8
SE3-1	**79**	**77**	1.4	**76**	2.3	**77**	1.4
SE3-2	**77**	**75**	2.0	**73**	3.1	**75**	1.4
SE3-3	**77**	**75**	2.0	**73**	3.4	**75**	1.1
SE3-4	**77**	**75**	2.5	**73**	3.9	**76**	1.2
SE3-5	**76**	**74**	2.0	**72**	3.4	**74**	1.1
SE3-6	**71**	**66**	5.0	63	8.0	**71**	0.0
SE3-7	**68**	64	4.0	61	7.0	**68**	0.0
SE4-1	**75**	**73**	2.0	**71**	3.1	**73**	1.4
SE4-10	**67**	**66**	1.0	65	2.9	**67**	0.7
SE4-2	**74**	**72**	2.0	**71**	2.8	**72**	1.8
SE4-3	**74**	**72**	2.0	**71**	2.9	**73**	1.6
SE4-4	**73**	**71**	2.0	**70**	2.9	**72**	1.6
SE4-5	**72**	**70**	2.0	**70**	2.7	**71**	1.9
SE4-6	**77**	**75**	2.0	**73**	3.4	**75**	1.1
SE4-7	**76**	**74**	2.0	**72**	3.4	**74**	1.1
SE4-8	**75**	**74**	1.0	**72**	2.4	**73**	1.1
SE4-9	**75**	**73**	2.0	**71**	3.4	**73**	1.1
SE5-1	**76**	**74**	1.5	**73**	2.8	**74**	1.4
SE5-2	**75**	**72**	3.0	**71**	3.8	**73**	1.8
SE5-3	**73**	**71**	2.4	**70**	3.2	**72**	1.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

Table J-6 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	**Overall Noise Reduction (dBA)**	**1999 (dBA)**	**Overall Noise Reduction (dBA)**
M-19	**83**	**80**	3.6	**79**	4.0
M-2	**81**	**79**	2.0	**76**	5.0
M-4	**80**	**76**	4.5	**74**	6.7
M-7	**82**	**78**	4.6	**76**	6.0
SE1-1	**80**	**76**	4.2	**75**	5.0
SE1-10	**79**	**76**	3.6	**74**	5.0
SE1-11	**80**	**77**	3.0	**76**	4.6
SE1-12	**81**	**77**	3.5	**76**	4.8
SE1-13	**82**	**78**	4.0	**76**	5.4
SE1-14	**82**	**75**	7.0	**72**	10.0
SE1-2	**81**	**76**	4.4	**75**	6.0
SE1-3	**82**	**78**	4.0	**76**	5.4
SE1-4	**81**	**77**	4.1	**76**	5.4
SE1-5	**83**	**77**	6.0	**74**	9.0
SE1-6 (Park)	**82**	**79**	2.9	**79**	3.1
SE1-7	**80**	**76**	4.3	**75**	5.3
SE1-8	**83**	**78**	4.2	**78**	4.9
SE1-9	**81**	**77**	4.3	**76**	5.3
SE2-1	**80**	**77**	3.2	**75**	5.0
SE2-10	**79**	**75**	3.1	**74**	5.0
SE2-11	**77**	**73**	4.6	**71**	6.0
SE2-12	**73**	**67**	6.0	64	9.0
SE2-2	**75**	**71**	4.1	**70**	5.4
SE2-3	**78**	**74**	3.8	**73**	5.0
SE2-4	**81**	**77**	3.8	**75**	5.5
SE2-5	**80**	**76**	3.8	**74**	5.5

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-6	**78**	**74**	3.9	**73**	5.5
SE2-7	**80**	**76**	3.1	**75**	5.0
SE2-8	**79**	**75**	3.3	**73**	5.4
SE2-9	**78**	**75**	2.3	**74**	4.2
SE3-1	**79**	**76**	3.0	**74**	4.4
SE3-2	**77**	**73**	3.4	**72**	5.0
SE3-3	**77**	**73**	3.1	**72**	5.0
SE3-4	**77**	**73**	3.6	**72**	5.5
SE3-5	**76**	**72**	3.1	**71**	5.0
SE3-6	**71**	**66**	5.0	63	8.0
SE3-7	**68**	64	4.0	61	7.0
SE4-1	**75**	**71**	3.4	**70**	5.0
SE4-10	**67**	**66**	1.7	63	4.0
SE4-2	**74**	**70**	3.8	**69**	5.0
SE4-3	**74**	**71**	3.6	**69**	5.0
SE4-4	**73**	**70**	3.6	**68**	5.0
SE4-5	**72**	**69**	3.9	**67**	5.0
SE4-6	**77**	**73**	3.1	**72**	5.0
SE4-7	**76**	**72**	3.1	**71**	5.0
SE4-8	**75**	**72**	2.1	**71**	4.0
SE4-9	**75**	**71**	3.1	**70**	5.0
SE5-1	**76**	**73**	2.8	**71**	4.5
SE5-2	**75**	**70**	4.8	**69**	6.0
SE5-3	**73**	**69**	4.1	**68**	5.4

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

Table J-7: Comparison of Total Additional Noise Reduction Provided by NoiseShield Type FS Absorptive Materials (SE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**82**	1.0	**82**	1.4	**76**	7.9
M-2	**81**	**79**	2.0	**68**	13.0	**81**	0.0
M-4	**80**	**77**	3.7	**73**	7.8	**79**	1.3
M-7	**82**	**79**	3.0	**77**	4.9	**79**	3.6
SE1-1	**80**	**78**	2.0	**77**	2.9	**74**	5.8
SE1-10	**79**	**77**	2.0	**75**	3.9	**76**	3.6
SE1-11	**80**	**79**	1.6	**76**	3.9	**78**	1.9
SE1-12	**81**	**79**	1.8	**77**	3.4	**77**	3.1
SE1-13	**82**	**79**	2.4	**77**	4.3	**78**	3.1
SE1-14	**82**	**75**	7.0	64	18.0	**82**	0.0
SE1-2	**81**	**78**	3.0	**75**	5.3	**77**	3.1
SE1-3	**82**	**79**	2.4	**77**	4.3	**78**	3.1
SE1-4	**81**	**79**	2.4	**77**	4.0	**78**	3.6
SE1-5	**83**	**77**	6.0	**66**	17.0	**83**	0.0
SE1-6 (Park)	**82**	**82**	0.0	**82**	0.2	**73**	9.1
SE1-7	**80**	**78**	2.3	**77**	3.3	**76**	4.7
SE1-8	**83**	**81**	1.8	**80**	2.6	**76**	6.9
SE1-9	**81**	**79**	2.3	**78**	3.3	**77**	4.7
SE2-1	**80**	**78**	2.0	**75**	4.7	**77**	2.7
SE2-10	**79**	**77**	2.0	**73**	5.1	**76**	2.3
SE2-11	**77**	**74**	3.0	**72**	4.9	**74**	3.6
SE2-12	**73**	**67**	6.0	56	17.0	**73**	0.0
SE2-2	**75**	**73**	2.4	**71**	4.0	**72**	3.6
SE2-3	**78**	**76**	2.0	**74**	3.6	**74**	4.1
SE2-4	**81**	**78**	2.5	**75**	5.2	**78**	2.3
SE2-5	**80**	**77**	2.5	**74**	5.2	**77**	2.3
SE2-6	**78**	**76**	2.5	**73**	4.7	**75**	2.7

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-7	**80**	**78**	2.0	**74**	5.1	**77**	2.3
SE2-8	**79**	**76**	2.4	**73**	6.0	**76**	2.3
SE2-9	**78**	**77**	1.2	**73**	4.4	**76**	1.6
SE3-1	**79**	**77**	1.4	**75**	3.3	**75**	3.1
SE3-2	**77**	**75**	2.0	**72**	4.3	**73**	3.1
SE3-3	**77**	**75**	2.0	**71**	5.1	**74**	2.3
SE3-4	**77**	**75**	2.5	**71**	5.6	**74**	2.7
SE3-5	**76**	**74**	2.0	**70**	5.1	**73**	2.3
SE3-6	**71**	**66**	5.0	55	16.0	**71**	0.0
SE3-7	**68**	64	4.0	53	15.0	**68**	0.0
SE4-1	**75**	**73**	2.0	**70**	4.3	**71**	3.1
SE4-10	**67**	**66**	1.0	62	5.7	**66**	1.3
SE4-2	**74**	**72**	2.0	**70**	3.6	**70**	4.1
SE4-3	**74**	**72**	2.0	**70**	3.9	**71**	3.6
SE4-4	**73**	**71**	2.0	**69**	3.9	**70**	3.6
SE4-5	**72**	**70**	2.0	**69**	3.3	**68**	4.7
SE4-6	**77**	**75**	2.0	**71**	5.1	**74**	2.3
SE4-7	**76**	**74**	2.0	**70**	5.1	**73**	2.3
SE4-8	**75**	**74**	1.0	**70**	4.1	**72**	2.3
SE4-9	**75**	**73**	2.0	**69**	5.1	**72**	2.3
SE5-1	**76**	**74**	1.5	**71**	4.2	**72**	3.1
SE5-2	**75**	**72**	3.0	**70**	4.6	**71**	4.1
SE5-3	**73**	**71**	2.4	**69**	4.0	**70**	3.6

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

Table J-7 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-19	**83**	**75**	8.9	**71**	12.0
M-2	**81**	**79**	2.0	**68**	13.0
M-4	**80**	**75**	5.3	**66**	14.7
M-7	**82**	**76**	6.6	**68**	14.0
SE1-1	**80**	**72**	7.8	**67**	13.0
SE1-10	**79**	**74**	5.6	**66**	13.0
SE1-11	**80**	**75**	4.7	**68**	12.6
SE1-12	**81**	**75**	5.9	**68**	12.8
SE1-13	**82**	**76**	6.0	**68**	13.4
SE1-14	**82**	**75**	7.0	64	18.0
SE1-2	**81**	**74**	6.1	**67**	14.0
SE1-3	**82**	**76**	6.0	**68**	13.4
SE1-4	**81**	**75**	6.5	**68**	13.4
SE1-5	**83**	**77**	6.0	**66**	17.0
SE1-6 (Park)	**82**	**73**	9.5	**71**	11.1
SE1-7	**80**	**73**	7.5	**67**	13.3
SE1-8	**83**	**74**	8.2	**70**	12.9
SE1-9	**81**	**74**	7.5	**68**	13.3
SE2-1	**80**	**75**	4.7	**67**	13.0
SE2-10	**79**	**74**	4.3	**66**	13.0
SE2-11	**77**	**71**	6.6	63	14.0
SE2-12	**73**	**67**	6.0	56	17.0
SE2-2	**75**	**69**	6.5	62	13.4
SE2-3	**78**	**72**	6.1	65	13.0
SE2-4	**81**	**75**	5.2	**67**	13.6
SE2-5	**80**	**74**	5.2	**66**	13.6

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
SE2-6	**78**	**72**	5.6	65	13.5
SE2-7	**80**	**75**	4.3	**67**	13.0
SE2-8	**79**	**74**	4.3	65	13.4
SE2-9	**78**	**74**	3.5	**66**	12.3
SE3-1	**79**	**74**	5.0	**66**	12.4
SE3-2	**77**	**71**	5.1	64	13.0
SE3-3	**77**	**72**	4.3	64	13.0
SE3-4	**77**	**72**	4.7	64	13.5
SE3-5	**76**	**71**	4.3	63	13.0
SE3-6	**71**	**66**	5.0	55	16.0
SE3-7	**68**	64	4.0	53	15.0
SE4-1	**75**	**69**	5.1	62	13.0
SE4-10	**67**	65	2.3	55	12.0
SE4-2	**74**	**68**	6.1	61	13.0
SE4-3	**74**	**69**	5.6	61	13.0
SE4-4	**73**	**68**	5.6	60	13.0
SE4-5	**72**	**66**	6.7	59	13.0
SE4-6	**77**	**72**	4.3	64	13.0
SE4-7	**76**	**71**	4.3	63	13.0
SE4-8	**75**	**71**	3.3	63	12.0
SE4-9	**75**	**70**	4.3	62	13.0
SE5-1	**76**	**71**	4.2	63	12.6
SE5-2	**75**	**68**	7.1	61	14.0
SE5-3	**73**	**67**	6.5	60	13.4

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table J-2.

[2] – From Scenario 1 (Table J-3).

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APPENDIX K: Northeast Quadrant Noise Level Results

Table K-1: Existing (2004) Modeled Traffic Noise Levels (NE Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq} (dBA)	Households	Type[1]
M-14	**78**	**66**	**78**	1	C
M-18	**76**	**75**	**79**	8	MF
NE1-1	**77**	**67**	**77**	1	C
NE1-10	**75**	**73**	**77**	17	MF
NE1-11	**71**	**70**	**73**	32	MF
NE1-12	**69**	**66**	**71**	1	SF
NE1-13	**69**	**72**	**74**	40	MF
NE1-14	60	64	65	2	MF
NE1-15	**67**	**70**	**72**	24	MF
NE1-16	65	N/A	65	2	SF
NE1-2	**73**	**66**	**74**	2	C
NE1-3	**78**	**66**	**78**	1	C
NE1-4	**76**	**72**	**77**	13	MF
NE1-5	**75**	**72**	**77**	1	SF
NE1-6	**74**	**73**	**76**	5	MF
NE1-7	**74**	**72**	**76**	3	SF
NE1-8	**74**	**72**	**76**	5	MF
NE1-9	**70**	**70**	**73**	9	MF
NE2-1	**70**	**68**	**72**	1	C
NE2-10	**69**	**67**	**71**	10	MF
NE2-11	**68**	**66**	**70**	7	MF
NE2-12	**66**	65	**68**	11	MF
NE2-13	63	61	65	20	MF
NE2-14	62	61	65	20	MF
NE2-15	62	61	65	7	MF
NE2-2	**71**	**70**	**73**	1	C
NE2-3	**74**	**70**	**75**	6	MF
NE2-4	**74**	**72**	**76**	5	MF
NE2-5	**72**	**70**	**74**	28	MF
NE2-6	**71**	**70**	**73**	3	MF
NE2-7	**68**	**67**	**71**	10	MF
NE2-8	**72**	**70**	**74**	8	MF
NE2-9	**73**	**68**	**74**	24	MF
NE3-1	**71**	**70**	**73**	4	MF
NE3-10	58	56	60	44	MF
NE3-11	59	58	62	5	MF
NE3-2	**71**	**69**	**74**	1	C
NE3-3	**72**	**69**	**74**	2	SF
NE3-4	**69**	62	**70**	6	MF
NE3-5	**69**	**66**	**70**	3	MF
NE3-6	**69**	**70**	**72**	5	MF

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq} (dBA)	Households	Type[1]
NE3-7	**69**	**68**	**72**	2	SF
NE3-8	**66**	65	**69**	11	MF
NE3-9	62	58	63	9	MF
NE4-1	**71**	**69**	**73**	3	C
NE4-2	**70**	**68**	**72**	2	MF
NE4-6	**67**	**68**	**70**	18	MF
NE4-7	**68**	**68**	**71**	11	MF

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility.

Table K-2: 1999 Modeled Traffic Noise Levels (NE Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
M-14	**71**	**81**	**81**	1	C
M-18	**80**	**82**	**84**	8	MF
NE1-1	**72**	**80**	**81**	1	C
NE1-2	**71**	**77**	**78**	2	C
NE1-3	**71**	**82**	**82**	1	C
NE1-4	**76**	**79**	**81**	13	MF
NE1-5	**77**	**79**	**81**	1	SF
NE1-6	**76**	**78**	**80**	5	MF
NE1-7	**76**	**78**	**80**	3	SF
NE1-8	**76**	**78**	**80**	5	MF
NE1-9	**74**	**76**	**78**	9	MF
NE1-10	**79**	**81**	**83**	17	MF
NE1-11	**73**	**79**	**80**	32	MF
NE1-12	**69**	**77**	**77**	1	SF
NE1-13	**73**	**78**	**79**	40	MF
NE1-14	64	**73**	**73**	2	MF
NE1-15	**71**	**74**	**76**	24	MF
NE1-16	**72**	**74**	**76**	2	SF
NE2-1	**73**	**74**	**76**	1	C
NE2-2	**74**	**74**	**77**	1	C
NE2-3	**75**	**77**	**79**	6	MF
NE2-4	**76**	**78**	**80**	5	MF
NE2-5	**73**	**76**	**78**	28	MF
NE2-6	**73**	**76**	**78**	3	MF
NE2-7	**71**	**74**	**76**	10	MF
NE2-8	**73**	**79**	**80**	8	MF
NE2-9	**71**	**79**	**79**	24	MF
NE2-10	**70**	**75**	**76**	10	MF
NE2-11	**68**	**74**	**75**	7	MF
NE2-12	**68**	**71**	**73**	11	MF
NE2-13	64	**70**	**71**	20	MF

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
NE2-14	64	**70**	**71**	20	MF
NE2-15	65	**71**	**72**	7	MF
NE3-1	**73**	**74**	**77**	4	MF
NE3-2	**73**	**75**	**77**	1	C
NE3-3	**73**	**75**	**77**	2	SF
NE3-4	65	**74**	**75**	6	MF
NE3-5	**70**	**74**	**76**	3	MF
NE3-6	**73**	**75**	**77**	5	MF
NE3-7	**71**	**75**	**77**	2	SF
NE3-8	**68**	**72**	**73**	11	MF
NE3-9	61	**66**	**67**	9	MF
NE3-10	59	65	**66**	44	MF
NE3-11	63	**70**	**71**	5	MF
NE4-1	**74**	**74**	**77**	3	C
NE4-2	**71**	**74**	**76**	2	MF
NE4-6	**70**	**73**	**75**	18	MF
NE4-7	**71**	**73**	**75**	11	MF

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility.

Table K-3: Total Noise Reduction Provided With and Without an At-Grade Noise Wall (NE Quadrant)

Site	1999 No Wall[1] (dBA)	Scenario 1			
		Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
M-14	**81**	**70**	**79**	**80**	1.5
M-18	**84**	**75**	**71**	**77**	7.3
NE1-1	**81**	**71**	**78**	**79**	2.0
NE1-2	**78**	**69**	**75**	**76**	1.9
NE1-3	**82**	**70**	**80**	**81**	1.3
NE1-4	**81**	**75**	**78**	**80**	1.1
NE1-5	**81**	**76**	**70**	**79**	1.4
NE1-6	**80**	**76**	**74**	**78**	2.0
NE1-7	**80**	**75**	**73**	**77**	2.6
NE1-8	**80**	**75**	**73**	**77**	2.9
NE1-9	**78**	**72**	**70**	**74**	3.5
NE1-10	**83**	**72**	**72**	**75**	8.3
NE1-11	**80**	**69**	**70**	**72**	7.3
NE1-12	**77**	61	**67**	**68**	9.2
NE1-13	**79**	**70**	**67**	**72**	7.0
NE1-14	**73**	60	58	62	11.4
NE1-15	**76**	**69**	65	**71**	5.1
NE1-16	**72**	**70**	N/A	**70**	1.9
NE2-1	**76**	**71**	**72**	**75**	1.7
NE2-2	**77**	**73**	**73**	**76**	1.8
NE2-3	**79**	**73**	**76**	**78**	1.6
NE2-4	**80**	**75**	**75**	**78**	1.7
NE2-5	**78**	**72**	**72**	**75**	2.7
NE2-6	**78**	**72**	**71**	**75**	3.1
NE2-7	**76**	**70**	**68**	**72**	3.8
NE2-8	**80**	**72**	**70**	**74**	6.3
NE2-9	**79**	**69**	**71**	**73**	6.3
NE2-10	**76**	**69**	**67**	**71**	5.0
NE2-11	**75**	**67**	**66**	**70**	5.2
NE2-12	**73**	**66**	**66**	**69**	4.2
NE2-13	**71**	63	64	**67**	4.4
NE2-14	**71**	63	62	**66**	5.2

Site	1999 No Wall[1] (dBA)	Scenario 1 Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
NE2-15	**72**	64	61	**66**	6.3
NE3-1	**77**	**72**	**72**	**75**	1.8
NE3-2	**77**	**72**	**72**	**75**	1.8
NE3-3	**77**	**72**	**72**	**75**	2.3
NE3-4	**75**	64	**70**	**71**	3.7
NE3-5	**76**	**68**	**69**	**72**	3.9
NE3-6	**77**	**72**	**68**	**73**	4.0
NE3-7	**77**	**70**	**68**	**72**	4.4
NE3-8	**74**	**67**	**66**	**70**	3.9
NE3-9	**67**	60	64	**66**	1.8
NE3-10	**66**	58	60	62	4.1
NE3-11	**71**	61	58	63	7.7
NE4-1	**77**	**72**	**72**	**75**	1.7
NE4-2	**76**	**70**	**71**	**74**	2.5
NE4-6	**75**	**69**	**67**	**71**	3.7
NE4-7	**75**	**70**	**67**	**72**	3.7
Total Reductions Greater Than Scenario 2:					**44**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – From Table K-2.

Table K-3 Cont'd

Site	1999 No Wall[1] (dBA)	Scenario 2 Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
M-14	**81**	**70**	**79**	**80**	1.5
M-18	**84**	**76**	**72**	**78**	5.8
NE1-1	**81**	**71**	**78**	**79**	2.0
NE1-2	**78**	**69**	**75**	**76**	1.8
NE1-3	**82**	**70**	**80**	**81**	1.3
NE1-4	**81**	**75**	**78**	**80**	1.1
NE1-5	**81**	**76**	**77**	**80**	1.3
NE1-6	**80**	**76**	**75**	**78**	1.8

Site	1999 No Wall[1] (dBA)	Scenario 2 Direct Path With Wall (dBA)	Scenario 2 Reflected Path With Wall (dBA)	Scenario 2 Combined Noise (dBA)	Scenario 2 Noise Reduction
NE1-7	**80**	**75**	**74**	**77**	2.6
NE1-8	**80**	**75**	**73**	**77**	2.8
NE1-9	**78**	**72**	**71**	**75**	3.3
NE1-10	**83**	**74**	**73**	**76**	6.5
NE1-11	**80**	**69**	**71**	**73**	6.5
NE1-12	**77**	62	**68**	**69**	8.2
NE1-13	**79**	**70**	**71**	**74**	5.1
NE1-14	**73**	**59**	65	**66**	7.3
NE1-15	**76**	**70**	**70**	**73**	2.9
NE1-16	**72**	**70**	**N/A**	**70**	1.8
NE2-1	**76**	**71**	**72**	**75**	1.7
NE2-2	**77**	**73**	**73**	**76**	1.6
NE2-3	**79**	**74**	**76**	**78**	1.5
NE2-4	**80**	**75**	**76**	**78**	1.7
NE2-5	**78**	**72**	**72**	**75**	2.6
NE2-6	**78**	**72**	**71**	**75**	2.9
NE2-7	**76**	**70**	**69**	**72**	3.7
NE2-8	**80**	**72**	**71**	**74**	5.5
NE2-9	**79**	**69**	**72**	**74**	5.6
NE2-10	**76**	**69**	**68**	**71**	4.7
NE2-11	**75**	**67**	**67**	**70**	5.0
NE2-12	**73**	**66**	**66**	**69**	3.9
NE2-13	**71**	63	**66**	**67**	3.6
NE2-14	**71**	63	**66**	**68**	2.9
NE2-15	**72**	64	**69**	**70**	2.1
NE3-1	**77**	**72**	**72**	**75**	1.6
NE3-2	**77**	**72**	**73**	**76**	1.7
NE3-3	**77**	**72**	**72**	**75**	2.1
NE3-4	**75**	64	**70**	**71**	3.5
NE3-5	**76**	**68**	**70**	**72**	3.8
NE3-6	**77**	**72**	**69**	**73**	3.8
NE3-7	**77**	**70**	**69**	**72**	4.1
NE3-8	**74**	**67**	**67**	**70**	3.6
NE3-9	**67**	60	64	**66**	1.8

Site	1999 No Wall[1] (dBA)	Scenario 2			
		Direct Path With Wall (dBA)	Reflected Path With Wall (dBA)	Combined Noise (dBA)	Noise Reduction
NE3-10	**66**	57	62	64	2.4
NE3-11	**71**	61	**67**	**68**	2.7
NE4-1	**77**	**72**	**72**	**75**	1.7
NE4-2	**76**	**70**	**71**	**74**	2.4
NE4-6	**75**	**69**	**68**	**71**	3.7
NE4-7	**75**	**70**	**67**	**72**	3.6
Total Reductions Greater Than Scenario 1:					**0**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – From Table K-2.

Table K-4: Comparison of Total Additional Noise Reduction Provided by Acoustax Absorptive Materials (NE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	81	80	1.5	79	1.9	73	8.1
M-18	84	76	7.3	72	12.0	80	3.6
NE1-1	81	79	2.0	78	2.8	74	7.0
NE1-2	78	76	1.9	75	2.9	72	5.7
NE1-3	82	81	1.3	80	1.6	74	8.3
NE1-4	81	80	1.1	78	2.8	77	4.1
NE1-5	81	79	1.4	77	3.7	77	3.4
NE1-6	80	78	2.0	75	5.3	77	3.4
NE1-7	80	77	2.6	74	6.0	76	3.6
NE1-8	80	77	2.9	73	6.6	76	3.8
NE1-9	78	74	3.5	71	7.2	74	3.7
NE1-10	83	75	8.3	72	11.2	79	3.8
NE1-11	80	72	7.3	70	9.9	74	5.9
NE1-12	77	68	9.2	67	10.2	70	7.0
NE1-13	79	72	7.0	68	11.3	74	5.1
NE1-14	73	62	11.4	58	15.4	66	7.2
NE1-15	76	71	5.1	66	9.9	72	3.9
NE1-16	72	70	1.9	58	13.4	72	0.0
NE2-1	76	75	1.7	72	4.2	73	3.0
NE2-2	77	76	1.8	73	4.5	75	2.7
NE2-3	79	78	1.6	76	3.5	75	3.8
NE2-4	80	78	1.7	76	4.2	77	3.3
NE2-5	78	75	2.7	72	5.7	74	4.0
NE2-6	78	75	3.1	71	6.3	74	3.8
NE2-7	76	72	3.8	69	7.2	72	4.0
NE2-8	80	74	6.3	70	10.0	74	5.5

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-9	**79**	**73**	**6.3**	**71**	**8.3**	**73**	**6.7**
NE2-10	**76**	**71**	**5.0**	**68**	8.3	**70**	5.5
NE2-11	**75**	**70**	**5.2**	**67**	8.2	**69**	5.7
NE2-12	**73**	**69**	**4.2**	**66**	6.8	**68**	4.5
NE2-13	**71**	**67**	**4.4**	64	6.6	65	5.8
NE2-14	**71**	**66**	**5.2**	63	8.1	65	5.6
NE2-15	**72**	**66**	**6.3**	62	10.2	**66**	6.1
NE3-1	**77**	**75**	**1.8**	**72**	**4.8**	**74**	**3.1**
NE3-2	**77**	**75**	**1.8**	**73**	4.4	**73**	3.7
NE3-3	**77**	**75**	**2.3**	**72**	4.9	**73**	4.0
NE3-4	**75**	**71**	**3.7**	**70**	4.6	**67**	7.5
NE3-5	**76**	**72**	**3.9**	**69**	6.1	**70**	5.0
NE3-6	**77**	**73**	**4.0**	**69**	8.6	**73**	3.8
NE3-7	**77**	**72**	**4.4**	**69**	7.9	**72**	5.1
NE3-8	**74**	**70**	**3.9**	**67**	6.9	**68**	5.1
NE3-9	**67**	**66**	**1.8**	64	3.0	62	5.7
NE3-10	**66**	62	**4.1**	60	6.0	60	6.0
NE3-11	**71**	63	**7.7**	59	12.0	64	6.3
NE4-1	**77**	**75**	**1.7**	**73**	**4.3**	**74**	**2.8**
NE4-2	**76**	**73**	**2.5**	**71**	5.1	**72**	4.2
NE4-6	**75**	**71**	**3.7**	**68**	7.5	**71**	4.1
NE4-7	**75**	**72**	**3.7**	**67**	7.9	**71**	4.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-4 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**72**	**9.4**	**68**	**12.9**
M-18	**84**	**75**	**8.6**	65	**18.8**
NE1-1	**81**	**72**	**8.3**	**67**	**13.5**
NE1-2	**78**	**70**	**7.6**	64	**13.4**
NE1-3	**82**	**72**	**9.4**	**69**	**12.7**
NE1-4	**81**	**76**	**5.3**	**68**	**12.6**
NE1-5	**81**	**76**	**4.6**	**68**	**12.8**
NE1-6	**80**	**76**	**4.2**	**67**	**13.5**
NE1-7	**80**	**75**	**4.7**	**66**	**14.0**
NE1-8	**80**	**75**	**4.9**	65	**14.4**
NE1-9	**78**	**72**	5.4	63	15.0
NE1-10	**83**	**72**	**10.8**	63	**19.8**
NE1-11	**80**	**70**	**10.1**	61	**18.7**
NE1-12	**77**	62	**14.8**	56	**20.6**
NE1-13	**79**	**70**	**8.6**	60	**18.5**
NE1-14	**73**	60	**13.2**	50	**22.9**
NE1-15	**76**	**69**	**6.4**	59	**16.6**
NE1-16	**72**	**70**	**1.9**	58	**13.4**
NE2-1	**76**	**72**	**4.8**	63	**13.2**
NE2-2	**77**	**73**	**4.5**	64	**13.3**
NE2-3	**79**	**74**	**5.3**	**66**	**13.0**
NE2-4	**80**	**75**	**4.6**	**67**	**13.2**
NE2-5	**78**	**72**	5.2	63	14.2
NE2-6	**78**	**72**	5.3	63	14.5
NE2-7	**76**	**70**	5.9	61	15.3

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-8	**80**	**72**	**8.1**	62	**17.7**
NE2-9	**79**	**69**	**10.0**	62	**17.8**
NE2-10	**76**	**69**	7.2	60	16.5
NE2-11	**75**	**67**	7.7	58	16.7
NE2-12	**73**	**66**	7.0	57	15.6
NE2-13	**71**	63	7.8	55	15.9
NE2-14	**71**	63	7.6	54	16.6
NE2-15	**72**	64	8.0	54	17.7
NE3-1	**77**	**73**	**4.1**	63	**13.2**
NE3-2	**77**	**73**	4.6	64	13.3
NE3-3	**77**	**72**	5.1	64	13.7
NE3-4	**75**	**66**	9.3	60	15.1
NE3-5	**76**	**68**	7.1	60	15.3
NE3-6	**77**	**72**	5.5	62	15.5
NE3-7	**77**	**70**	6.5	61	15.9
NE3-8	**74**	**67**	6.4	58	15.4
NE3-9	**67**	61	6.7	54	13.2
NE3-10	**66**	58	7.9	50	15.6
NE3-11	**71**	61	9.3	52	19.2
NE4-1	**77**	**72**	**4.6**	64	**13.2**
NE4-2	**76**	**71**	5.3	62	14.0
NE4-6	**75**	**69**	5.6	60	15.2
NE4-7	**75**	**70**	5.3	60	15.2

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-5: Comparison of Total Additional Noise Reduction Provided by Sound Fighter Absorptive Materials (NE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**80**	**1.5**	**79**	1.9	**73**	8.0
M-18	**84**	**76**	**7.3**	**72**	12.0	**80**	3.6
NE1-1	**81**	**79**	**2.0**	**78**	2.8	**74**	7.0
NE1-2	**78**	**76**	**1.9**	**75**	2.9	**72**	5.6
NE1-3	**82**	**81**	**1.3**	**80**	1.6	**74**	8.2
NE1-4	**81**	**80**	**1.1**	**78**	2.8	**77**	4.1
NE1-5	**81**	**79**	**1.4**	**77**	3.7	**77**	3.4
NE1-6	**80**	**78**	**2.0**	**75**	5.3	**77**	3.3
NE1-7	**80**	**77**	**2.6**	**74**	6.0	**76**	3.6
NE1-8	**80**	**77**	**2.9**	**73**	6.6	**76**	3.7
NE1-9	**78**	**74**	**3.5**	**71**	7.2	**74**	3.6
NE1-10	**83**	**75**	**8.3**	**72**	11.2	**79**	3.8
NE1-11	**80**	**72**	**7.3**	**70**	9.9	**74**	5.8
NE1-12	**77**	**68**	**9.2**	**67**	10.2	**70**	7.0
NE1-13	**79**	**72**	**7.0**	**68**	11.2	**74**	5.1
NE1-14	**73**	62	**11.4**	58	15.3	**66**	7.2
NE1-15	**76**	**71**	**5.1**	**66**	9.9	**72**	3.9
NE1-16	**72**	**70**	**1.9**	59	13.1	**72**	0.0
NE2-1	**76**	**75**	**1.7**	**72**	4.2	**73**	3.0
NE2-2	**77**	**76**	**1.8**	**73**	4.5	**75**	2.7
NE2-3	**79**	**78**	**1.6**	**76**	3.5	**75**	3.7
NE2-4	**80**	**78**	**1.7**	**76**	4.2	**77**	3.3
NE2-5	**78**	**75**	**2.7**	**72**	5.7	**74**	3.9
NE2-6	**78**	**75**	**3.1**	**71**	6.3	**74**	3.8
NE2-7	**76**	**72**	**3.8**	**69**	7.1	**72**	4.0
NE2-8	**80**	**74**	**6.3**	**70**	10.0	**74**	5.4
NE2-9	**79**	**73**	**6.3**	**71**	8.3	**73**	6.7
NE2-10	**76**	**71**	**5.0**	**68**	8.3	**71**	5.5

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-11	**75**	**70**	**5.2**	**67**	8.2	**69**	5.6
NE2-12	**73**	**69**	**4.2**	**66**	6.8	**68**	4.5
NE2-13	**71**	**67**	**4.4**	64	6.6	65	5.8
NE2-14	**71**	**66**	**5.2**	63	8.1	65	5.6
NE2-15	**72**	**66**	**6.3**	62	10.2	**66**	6.0
NE3-1	**77**	**75**	**1.8**	**72**	4.8	**74**	3.1
NE3-2	**77**	**75**	**1.8**	**73**	4.4	**73**	3.6
NE3-3	**77**	**75**	**2.3**	**72**	4.9	**73**	4.0
NE3-4	**75**	**71**	**3.7**	**70**	4.6	**67**	7.4
NE3-5	**76**	**72**	**3.9**	**69**	6.1	**71**	5.0
NE3-6	**77**	**73**	**4.0**	**69**	8.5	**73**	3.8
NE3-7	**77**	**72**	**4.4**	**69**	7.8	**72**	5.0
NE3-8	**74**	**70**	**3.9**	**67**	6.8	**68**	5.0
NE3-9	**67**	**66**	**1.8**	64	3.0	62	5.7
NE3-10	**66**	62	**4.1**	60	5.9	60	6.0
NE3-11	**71**	63	**7.7**	59	11.9	65	6.2
NE4-1	**77**	**75**	**1.7**	**73**	4.3	**74**	2.8
NE4-2	**76**	**73**	**2.5**	**71**	5.1	**72**	4.2
NE4-6	**75**	**71**	**3.7**	**68**	7.5	**71**	4.1
NE4-7	**75**	**72**	**3.7**	**67**	7.9	**71**	4.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-5 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**72**	9.3	**68**	12.7
M-18	**84**	**75**	8.6	65	18.6
NE1-1	**81**	**73**	8.2	**67**	13.2
NE1-2	**78**	**70**	7.6	64	13.2
NE1-3	**82**	**73**	9.4	**69**	12.5
NE1-4	**81**	**76**	5.2	**69**	12.4
NE1-5	**81**	**76**	4.5	**68**	12.6
NE1-6	**80**	**76**	4.2	**67**	13.3
NE1-7	**80**	**75**	4.6	**66**	13.8
NE1-8	**80**	**75**	4.8	**66**	14.2
NE1-9	**78**	**72**	5.4	63	14.8
NE1-10	**83**	**72**	10.8	63	19.5
NE1-11	**80**	**70**	10.0	61	18.5
NE1-12	**77**	62	14.8	57	20.4
NE1-13	**79**	**70**	8.6	61	18.3
NE1-14	**73**	60	13.2	51	22.7
NE1-15	**76**	**69**	6.4	59	16.4
NE1-16	**72**	**70**	1.9	59	13.1
NE2-1	**76**	**72**	4.8	63	13.0
NE2-2	**77**	**73**	4.5	64	13.0
NE2-3	**79**	**74**	5.2	**66**	12.8
NE2-4	**80**	**75**	4.6	**67**	12.9
NE2-5	**78**	**72**	5.2	64	14.0
NE2-6	**78**	**72**	5.3	63	14.3
NE2-7	**76**	**70**	5.9	61	15.0

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-8	**80**	**72**	8.1	62	17.5
NE2-9	**79**	**69**	9.9	62	17.6
NE2-10	**76**	**69**	7.2	60	16.2
NE2-11	**75**	**67**	7.7	59	16.5
NE2-12	**73**	**66**	6.9	58	15.4
NE2-13	**71**	63	7.8	55	15.7
NE2-14	**71**	63	7.6	54	16.4
NE2-15	**72**	64	8.0	55	17.5
NE3-1	**77**	**73**	4.1	64	13.0
NE3-2	**77**	**73**	4.6	64	13.1
NE3-3	**77**	**72**	5.0	64	13.5
NE3-4	**75**	**66**	9.3	60	14.9
NE3-5	**76**	**68**	7.1	60	15.1
NE3-6	**77**	**72**	5.5	62	15.3
NE3-7	**77**	**70**	6.5	61	15.7
NE3-8	**74**	**67**	6.4	58	15.2
NE3-9	**67**	61	6.6	54	13.0
NE3-10	**66**	58	7.9	51	15.4
NE3-11	**71**	61	9.3	52	19.0
NE4-1	**77**	**72**	4.6	64	13.0
NE4-2	**76**	**71**	5.3	62	13.8
NE4-6	**75**	**69**	5.6	60	15.0
NE4-7	**75**	**70**	5.3	60	15.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-6: Comparison of Total Additional Noise Reduction Provided by Carsonite Composite Panels Absorptive Materials (NE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**80**	**1.5**	**80**	1.7	**79**	2.6
M-18	**84**	**76**	**7.3**	**75**	9.2	**82**	1.6
NE1-1	**81**	**79**	**2.0**	**78**	2.4	**78**	2.5
NE1-2	**78**	**76**	**1.9**	**75**	2.4	**75**	2.2
NE1-3	**82**	**81**	**1.3**	**80**	1.5	**79**	2.7
NE1-4	**81**	**80**	**1.1**	**79**	1.9	**79**	1.7
NE1-5	**81**	**79**	**1.4**	**78**	2.5	**79**	1.5
NE1-6	**80**	**78**	**2.0**	**77**	3.5	**79**	1.5
NE1-7	**80**	**77**	**2.6**	**76**	4.1	**78**	1.6
NE1-8	**80**	**77**	**2.9**	**75**	4.5	**78**	1.6
NE1-9	**78**	**74**	**3.5**	**73**	5.1	**76**	1.6
NE1-10	**83**	**75**	**8.3**	**73**	9.6	**81**	1.6
NE1-11	**80**	**72**	**7.3**	**71**	8.5	**77**	2.2
NE1-12	**77**	**68**	**9.2**	**67**	9.7	**75**	2.5
NE1-13	**79**	**72**	**7.0**	**70**	8.8	**77**	2.0
NE1-14	**73**	62	**11.4**	60	13.1	**71**	2.5
NE1-15	**76**	**71**	**5.1**	**69**	7.0	**74**	1.7
NE1-16	**72**	**70**	**1.9**	**67**	4.9	**72**	0.0
NE2-1	**76**	**75**	**1.7**	**74**	2.9	**75**	1.4
NE2-2	**77**	**76**	**1.8**	**74**	3.0	**76**	1.2
NE2-3	**79**	**78**	**1.6**	**77**	2.5	**78**	1.6
NE2-4	**80**	**78**	**1.7**	**77**	2.9	**78**	1.5
NE2-5	**78**	**75**	**2.7**	**74**	4.1	**76**	1.7
NE2-6	**78**	**75**	**3.1**	**73**	4.5	**76**	1.6
NE2-7	**76**	**72**	**3.8**	**71**	5.3	**74**	1.7
NE2-8	**80**	**74**	**6.3**	**72**	7.9	**78**	2.1
NE2-9	**79**	**73**	**6.3**	**72**	7.3	**77**	2.4

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-10	**76**	**71**	**5.0**	**70**	6.5	**74**	2.1
NE2-11	**75**	**70**	**5.2**	**68**	6.6	**73**	2.2
NE2-12	**73**	**69**	**4.2**	**68**	5.4	**71**	1.9
NE2-13	**71**	**67**	**4.4**	**66**	5.5	**69**	2.2
NE2-14	**71**	**66**	**5.2**	64	6.5	**69**	2.1
NE2-15	**72**	**66**	**6.3**	64	8.0	**70**	2.3
NE3-1	**77**	**75**	**1.8**	**74**	3.1	**75**	1.4
NE3-2	**77**	**75**	**1.8**	**74**	3.0	**76**	1.6
NE3-3	**77**	**75**	**2.3**	**74**	3.5	**76**	1.7
NE3-4	**75**	**71**	**3.7**	**71**	4.2	**72**	2.5
NE3-5	**76**	**72**	**3.9**	**71**	4.9	**74**	2.0
NE3-6	**77**	**73**	**4.0**	**71**	5.9	**75**	1.6
NE3-7	**77**	**72**	**4.4**	**71**	5.9	**75**	2.0
NE3-8	**74**	**70**	**3.9**	**68**	5.3	**71**	2.0
NE3-9	**67**	**66**	**1.8**	65	2.4	65	2.2
NE3-10	**66**	62	**4.1**	61	5.0	64	2.2
NE3-11	**71**	63	**7.7**	61	9.5	**68**	2.3
NE4-1	**77**	**75**	**1.7**	**74**	2.9	**76**	1.3
NE4-2	**76**	**73**	**2.5**	**72**	3.7	**74**	1.8
NE4-6	**75**	**71**	**3.7**	**70**	5.4	**73**	1.7
NE4-7	**75**	**72**	**3.7**	**70**	5.5	**74**	1.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-6 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**77**	4.1	**77**	4.5
M-18	**84**	**76**	8.0	**73**	10.3
NE1-1	**81**	**76**	4.3	**76**	5.0
NE1-2	**78**	**73**	4.1	**73**	4.9
NE1-3	**82**	**78**	3.9	**78**	4.3
NE1-4	**81**	**78**	2.9	**77**	4.1
NE1-5	**81**	**78**	2.8	**76**	4.4
NE1-6	**80**	**77**	3.1	**75**	5.0
NE1-7	**80**	**76**	3.6	**74**	5.6
NE1-8	**80**	**76**	3.9	**74**	5.9
NE1-9	**78**	**73**	4.5	**71**	6.5
NE1-10	**83**	**73**	9.5	**72**	11.3
NE1-11	**80**	**71**	8.5	**69**	10.3
NE1-12	**77**	**66**	11.3	65	12.2
NE1-13	**79**	**71**	7.8	**69**	10.0
NE1-14	**73**	61	12.3	59	14.5
NE1-15	**76**	**70**	5.8	**68**	8.1
NE1-16	**72**	**70**	1.9	**67**	4.9
NE2-1	**76**	**73**	3.1	**72**	4.8
NE2-2	**77**	**74**	3.0	**73**	4.8
NE2-3	**79**	**76**	3.2	**75**	4.6
NE2-4	**80**	**77**	3.0	**75**	4.7
NE2-5	**78**	**74**	3.9	**72**	5.7
NE2-6	**78**	**74**	4.1	**72**	6.1

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-7	**76**	**71**	4.8	**69**	6.8
NE2-8	**80**	**73**	7.2	**71**	9.3
NE2-9	**79**	**71**	7.9	**70**	9.4
NE2-10	**76**	**70**	6.0	**68**	8.0
NE2-11	**75**	**69**	6.4	**67**	8.2
NE2-12	**73**	**68**	5.4	**66**	7.2
NE2-13	**71**	65	5.9	64	7.4
NE2-14	**71**	65	6.3	63	8.2
NE2-15	**72**	65	7.1	63	9.3
NE3-1	**77**	**74**	2.9	**72**	4.8
NE3-2	**77**	**74**	3.1	**72**	4.8
NE3-3	**77**	**74**	3.5	**72**	5.3
NE3-4	**75**	**69**	5.8	**68**	6.7
NE3-5	**76**	**70**	5.3	**69**	6.9
NE3-6	**77**	**72**	4.8	**70**	7.0
NE3-7	**77**	**71**	5.4	**69**	7.4
NE3-8	**74**	**68**	5.1	**67**	6.9
NE3-9	**67**	64	3.7	63	4.8
NE3-10	**66**	60	5.8	59	7.1
NE3-11	**71**	62	8.5	60	10.7
NE4-1	**77**	**74**	3.0	**72**	4.8
NE4-2	**76**	**72**	3.8	**70**	5.5
NE4-6	**75**	**70**	4.7	**68**	6.8
NE4-7	**75**	**71**	4.5	**69**	6.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-7: Comparison of Total Additional Noise Reduction Provided by Noiseshield Type FS Absorptive Materials (NE Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**80**	**1.5**	**79**	1.9	**73**	7.9
M-18	**84**	**76**	**7.3**	**72**	12.0	**80**	3.6
NE1-1	**81**	**79**	**2.0**	**78**	2.8	**74**	6.9
NE1-2	**78**	**76**	**1.9**	**75**	2.9	**72**	5.6
NE1-3	**82**	**81**	**1.3**	**80**	1.6	**74**	8.1
NE1-4	**81**	**80**	**1.1**	**78**	2.8	**77**	4.0
NE1-5	**81**	**79**	**1.4**	**77**	3.7	**77**	3.4
NE1-6	**80**	**78**	**2.0**	**75**	5.2	**77**	3.3
NE1-7	**80**	**77**	**2.6**	**74**	6.0	**76**	3.6
NE1-8	**80**	**77**	2.9	**73**	6.5	**76**	3.7
NE1-9	**78**	**74**	3.5	**71**	**7.2**	**74**	**3.6**
NE1-10	**83**	**75**	8.3	**72**	11.2	**79**	3.8
NE1-11	**80**	**72**	7.3	**70**	9.9	**74**	5.8
NE1-12	**77**	**68**	9.2	**67**	10.1	**70**	6.9
NE1-13	**79**	**72**	7.0	**68**	11.2	**74**	5.1
NE1-14	**73**	62	11.4	58	15.3	**66**	7.1
NE1-15	**76**	**71**	5.1	**66**	9.8	**72**	3.9
NE1-16	**72**	**70**	1.9	59	12.9	**72**	0.0
NE2-1	**76**	**75**	1.7	**72**	4.1	**73**	2.9
NE2-2	**77**	**76**	1.8	**73**	4.5	**75**	2.7
NE2-3	**79**	**78**	1.6	**76**	3.4	**75**	3.7
NE2-4	**80**	**78**	1.7	**76**	4.2	**77**	3.3
NE2-5	**78**	**75**	2.7	**72**	5.6	**74**	3.9
NE2-6	**78**	**75**	3.1	**71**	6.3	**74**	3.8
NE2-7	**76**	**72**	3.8	**69**	**7.1**	**72**	**4.0**

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-8	**80**	**74**	6.3	**70**	10.0	**74**	5.4
NE2-9	**79**	**73**	6.3	**71**	8.3	**73**	6.6
NE2-10	**76**	**71**	5.0	**68**	8.3	**71**	5.4
NE2-11	**75**	**70**	5.2	**67**	8.2	**69**	5.6
NE2-12	**73**	**69**	4.2	**66**	6.8	**69**	4.5
NE2-13	**71**	**67**	4.4	64	**6.6**	65	**5.7**
NE2-14	**71**	**66**	5.2	63	**8.1**	65	**5.5**
NE2-15	**72**	**66**	6.3	62	**10.1**	**66**	**6.0**
NE3-1	**77**	**75**	1.8	**72**	4.8	**74**	3.1
NE3-2	**77**	**75**	1.8	**73**	4.4	**74**	3.6
NE3-3	**77**	**75**	2.3	**72**	4.9	**73**	4.0
NE3-4	**75**	**71**	3.7	**70**	**4.6**	**67**	**7.4**
NE3-5	**76**	**72**	3.9	**69**	**6.1**	**71**	**4.9**
NE3-6	**77**	**73**	4.0	**69**	8.5	**73**	3.8
NE3-7	**77**	**72**	4.4	**69**	7.8	**72**	5.0
NE3-8	**74**	**70**	3.9	**67**	**6.8**	**68**	**5.0**
NE3-9	**67**	**66**	1.8	64	**3.0**	62	**5.6**
NE3-10	**66**	62	4.1	60	**5.9**	60	**5.9**
NE3-11	**71**	63	7.7	59	**11.9**	65	**6.2**
NE4-1	**77**	**75**	1.7	**73**	4.3	**74**	2.8
NE4-2	**76**	**73**	2.5	**71**	**5.1**	**72**	**4.1**
NE4-6	**75**	**71**	3.7	**68**	**7.5**	**71**	**4.1**
NE4-7	**75**	**72**	3.7	**67**	**7.8**	**71**	**4.0**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

Table K-7 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-14	**81**	**72**	9.2	**69**	12.5
M-18	**84**	**75**	8.6	65	18.3
NE1-1	**81**	**73**	8.2	**68**	13.0
NE1-2	**78**	**70**	7.5	65	12.9
NE1-3	**82**	**73**	9.3	**70**	12.3
NE1-4	**81**	**76**	5.2	**69**	12.2
NE1-5	**81**	**76**	4.5	**68**	12.4
NE1-6	**80**	**76**	4.2	**67**	13.0
NE1-7	**80**	**75**	4.6	**66**	13.6
NE1-8	**80**	**75**	4.8	**66**	14.0
NE1-9	**78**	**73**	**5.4**	63	14.6
NE1-10	**83**	**72**	10.8	63	19.3
NE1-11	**80**	**70**	10.0	61	18.3
NE1-12	**77**	62	14.7	57	20.2
NE1-13	**79**	**70**	8.6	61	18.1
NE1-14	**73**	60	13.2	51	22.5
NE1-15	**76**	**69**	6.4	60	16.1
NE1-16	**72**	**70**	1.9	59	12.9
NE2-1	**76**	**72**	4.7	64	12.8
NE2-2	**77**	**73**	4.5	65	12.8
NE2-3	**79**	**74**	5.2	**67**	12.6
NE2-4	**80**	**75**	4.5	**67**	12.7
NE2-5	**78**	**72**	5.2	64	13.8
NE2-6	**78**	**72**	5.3	64	14.1
NE2-7	**76**	**70**	**5.9**	61	14.8

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NE2-8	**80**	**72**	8.1	63	17.3
NE2-9	**79**	**70**	9.9	62	17.4
NE2-10	**76**	**69**	7.2	60	16.0
NE2-11	**75**	**67**	7.7	59	16.3
NE2-12	**73**	**66**	6.9	58	15.2
NE2-13	**71**	63	**7.7**	56	15.5
NE2-14	**71**	63	**7.6**	55	16.2
NE2-15	**72**	64	**8.0**	55	17.3
NE3-1	**77**	**73**	4.1	64	12.8
NE3-2	**77**	**73**	4.6	64	12.8
NE3-3	**77**	**72**	5.0	64	13.3
NE3-4	**75**	**66**	**9.2**	60	14.7
NE3-5	**76**	**68**	**7.1**	61	14.9
NE3-6	**77**	**72**	5.5	62	15.1
NE3-7	**77**	**70**	6.5	61	15.4
NE3-8	**74**	**67**	**6.4**	59	15.0
NE3-9	**67**	61	**6.6**	55	12.8
NE3-10	**66**	58	**7.9**	51	15.1
NE3-11	**71**	61	**9.3**	52	18.7
NE4-1	**77**	**72**	4.6	64	12.8
NE4-2	**76**	**71**	**5.3**	62	13.5
NE4-6	**75**	**70**	**5.6**	60	14.8
NE4-7	**75**	**70**	**5.3**	61	14.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table K-2.

[2] – From Scenario 1 (Table K-3).

APPENDIX L: Northwest Quadrant Noise Level Results

Table L-1: Existing (2004) Modeled Traffic Noise Levels (NW Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq}	Households	Type[1]
M-16	**78**	**81**	**83**	1	SF
NW1-1	**78**	**80**	**82**	2	SF
NW1-2	**78**	**81**	**83**	2	SF
NW1-3	**79**	**80**	**83**	3	SF
NW1-4	**80**	**82**	**84**	10	MF
NW1-5	**79**	**79**	**82**	3	SF/MF
NW1-6	**79**	N/A	**79**	3	SF
NW1-7	**80**	N/A	**80**	3	SF/MF
NW1-8	**79**	N/A	**79**	2	SF
NW1-9	**79**	N/A	**79**	3	SF/MF
NW1-10	**81**	N/A	**81**	2	MF
NW2-1	**72**	**74**	**76**	1	SF
NW2-2	**74**	**76**	**78**	15	MF
NW2-3	**75**	**77**	**79**	4	SF/MF
NW2-4	**75**	N/A	**75**	4	SF/MF
NW2-5	**75**	N/A	**75**	6	MF
NW2-6	**74**	N/A	**74**	3	SF
NW2-7	**74**	N/A	**74**	3	SF/MF
NW2-8	**75**	**75**	**78**	30	SCH
NW2-9	**71**	**73**	**75**	-[2]	-[2]
NW3-1	**67**	**72**	**73**	6	MF
NW3-2	**66**	**72**	**73**	2	MF
NW3-3	**71**	**73**	**75**	4	MF
NW3-4	**71**	**76**	**77**	2	SF
NW3-5	**73**	**75**	**77**	3	SF/MF
NW3-6	**71**	N/A	**71**	3	SF
NW3-7	**71**	N/A	**71**	5	SF/MF
NW3-8	**71**	N/A	**71**	3	SF/MF
NW3-9	**71**	**77**	**78**	10	MF
NW4-1	**70**	**72**	**74**	7	MF
NW4-2	**67**	**72**	**73**	10	MF
NW4-3	**72**	**73**	**76**	5	MF
NW4-4	**72**	**72**	**75**	3	SF
NW4-5	**70**	**69**	**73**	5	SF/MF
NW4-6	65	63	**67**	5	SF/MF
NW4-7	**67**	N/A	**67**	7	SF/MF
NW4-8	**69**	N/A	**69**	7	MF
NW4-9	**68**	N/A	**68**	4	SF/MF
NW4-10	**68**	N/A	**68**	4	MF
NW4-11	**69**	N/A	**69**	2	SF
NW5-1	**69**	**71**	**73**	3	SF

Site	Direct (dBA)	Reflected (dBA)	Total L_{eq}	Households	Type[1]
NW5-2	**70**	**70**	**73**	3	SF
NW5-3	**69**	**69**	**72**	6	SF/MF
NW5-4	**67**	65	**69**	4	SF
NW5-5	**67**	N/A	**67**	5	MF
NW5-6	**66**	N/A	**66**	1	SF

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos/ Duplex, Triplex or 4-Plex; SF = Single Family; P = Park; C = Community Facility, SCH = School.

[2] – A commercial facility with outdoor use area not considered in the benefited household count.

Table L-2: 1999 Modeled Traffic Noise Levels (NW Quadrant)

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
M-16	**79**	**81**	**83**	1	SF
NW1-1	**78**	**80**	**82**	2	SF
NW1-2	**79**	**80**	**83**	2	SF
NW1-3	**80**	**80**	**83**	3	SF
NW1-4	**82**	**82**	**85**	10	MF
NW1-5	**81**	**80**	**84**	3	SF/MF
NW1-6	**82**	N/A	**82**	3	SF
NW1-7	**82**	N/A	**82**	3	SF/MF
NW1-8	**80**	N/A	**80**	2	SF
NW1-9	**81**	N/A	**81**	3	SF/MF
NW1-10	**81**	N/A	**81**	2	MF
NW2-1	**73**	**74**	**77**	1	SF
NW2-2	**75**	**76**	**79**	15	MF
NW2-3	**75**	**77**	**79**	4	SF/MF
NW2-4	**77**	N/A	**77**	4	SF/MF
NW2-5	**77**	N/A	**77**	6	MF
NW2-6	**75**	N/A	**75**	3	SF
NW2-7	**74**	N/A	**74**	3	SF/MF
NW2-8	**76**	**78**	**80**	30	SCH
NW2-9	**71**	**75**	**76**	N/A	N/A
NW3-1	**68**	**72**	**73**	6	MF
NW3-2	**67**	**72**	**73**	2	MF
NW3-3	**71**	**73**	**75**	4	MF
NW3-4	**72**	**76**	**77**	2	SF
NW3-5	**74**	**76**	**78**	3	SF/MF
NW3-6	**72**	N/A	**72**	3	SF
NW3-7	**72**	N/A	**72**	5	SF/MF
NW3-8	**71**	N/A	**71**	3	SF/MF
NW3-9	**72**	**73**	**76**	10	MF
NW4-1	**70**	**73**	**75**	7	MF
NW4-2	**68**	**73**	**74**	10	MF
NW4-3	**72**	**74**	**76**	5	MF

Site	Direct (dBA)	Reflected (dBA)	Combined Direct & Reflected Noise (dBA)	Households	Type[1]
NW4-4	**72**	**73**	**76**	3	SF
NW4-5	**71**	**70**	**74**	5	SF/MF
NW4-6	**66**	64	**68**	5	SF/MF
NW4-7	**68**	N/A	**68**	7	SF/MF
NW4-8	**71**	N/A	**71**	7	MF
NW4-9	**70**	N/A	**70**	4	SF/MF
NW4-10	**69**	N/A	**69**	4	MF
NW4-11	**69**	N/A	**69**	2	SF
NW5-1	**70**	**72**	**74**	3	SF
NW5-2	**71**	**72**	**75**	3	SF
NW5-3	**69**	**70**	**73**	6	SF/MF
NW5-4	**68**	**66**	**70**	4	SF
NW5-5	**68**	N/A	**68**	5	MF
NW5-6	**67**	N/A	**67**	1	SF

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location

[1] – Types: MF = Appartments/Condos; SF = Single Family; P = Park; C = Community Facility.

Table L-3: Total Direct Path Noise Reduction Provided With and Without an At-Grade Noise Wall (NW Quadrant)

Site	Combined 1999 No Wall[1] (dBA)	Scenario 1			
		1999 Direct Path With Wall (dBA)	1999 Reflected Path With Wall (dBA)	1999 Combined Noise (dBA)	Noise Reduction
M-16	**83**	**78**	**80**	**82**	1.3
NW1-1	**82**	**77**	**78**	**81**	1.5
NW1-10	**81**	**74**	N/A	**74**	7.0
NW1-2	**83**	**77**	**79**	**81**	1.5
NW1-3	**83**	**77**	**78**	**80**	2.7
NW1-4	**85**	**76**	**78**	**80**	5.1
NW1-5	**84**	**76**	**73**	**78**	5.9
NW1-6	**82**	**76**	N/A	**76**	6.1
NW1-7	**82**	**74**	N/A	**74**	7.6
NW1-8	**80**	**74**	N/A	**74**	5.6
NW1-9	**81**	**74**	N/A	**74**	6.8
NW2-1	**77**	**74**	**73**	**76**	0.4
NW2-2	**79**	**71**	**74**	**76**	2.6
NW2-3	**79**	**73**	**75**	**77**	2.2
NW2-4	**77**	**74**	N/A	**74**	2.9
NW2-5	**77**	**73**	N/A	**73**	3.8
NW2-6	**75**	**73**	N/A	**73**	2.5
NW2-7	**74**	**68**	N/A	**68**	6.4
NW2-8	**80**	**75**	**74**	**77**	3.0
NW2-9	**76**	**69**	**74**	**75**	1.6
NW3-1	**73**	**66**	**70**	**72**	1.9
NW3-2	**73**	65	**70**	**71**	2.1
NW3-3	**75**	**70**	**71**	**74**	1.6
NW3-4	**77**	**71**	**73**	**75**	2.4
NW3-5	**78**	**72**	**72**	**75**	2.8
NW3-6	**72**	**69**	N/A	**69**	3.1
NW3-7	**72**	**69**	N/A	**69**	2.7
NW3-8	**71**	**69**	N/A	**69**	1.7
NW3-9	**76**	**70**	**71**	**73**	2.1
NW4-1	**75**	**69**	**70**	**72**	2.3
NW4-10	**69**	**67**	N/A	**67**	1.8
NW4-11	**69**	**67**	N/A	**67**	1.7
NW4-2	**74**	**67**	**70**	**72**	2.5
NW4-3	**76**	**71**	**71**	**74**	2.4
NW4-4	**76**	**71**	**70**	**74**	2.0
NW4-5	**74**	**70**	**68**	**72**	1.7
NW4-6	**68**	65	62	**66**	1.8
NW4-7	**68**	64	N/A	64	3.7
NW4-8	**71**	**67**	N/A	**67**	3.7
NW4-9	**70**	**67**	N/A	**67**	2.8
NW5-1	**74**	**69**	**70**	**72**	2.0
NW5-2	**75**	**70**	**69**	**72**	2.5
NW5-3	**73**	**68**	**67**	**71**	1.9
NW5-4	**70**	**66**	64	**68**	1.9
NW5-5	**68**	**66**	N/A	**66**	2.3
NW5-6	**67**	64	N/A	64	2.7

Site	Combined 1999 No Wall[1] (dBA)	Scenario 1 1999 Direct Path With Wall (dBA)	1999 Reflected Path With Wall (dBA)	1999 Combined Noise (dBA)	Noise Reduction
Total Reductions Greater Than Scenario 2:					14

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location.

[1] – From Table L-2.

Table L-3 Cont'd

Site	Combined 1999 No Wall[1] (dBA)	Scenario 2			
		1999 Direct Path With Wall (dBA)	1999 Reflected Path With Wall (dBA)	1999 Combined Noise (dBA)	Noise Reduction
M-16	**83**	**77**	**80**	**81**	1.7
NW1-1	**82**	**77**	**78**	**80**	1.7
NW1-10	**81**	**77**	N/A	**77**	4.4
NW1-2	**83**	**77**	**78**	**81**	1.7
NW1-3	**83**	**78**	**77**	**81**	2.3
NW1-4	**85**	**79**	**76**	**81**	4.4
NW1-5	**84**	**78**	**72**	**79**	5.0
NW1-6	**82**	**77**	N/A	**77**	4.6
NW1-7	**82**	**76**	N/A	**76**	6.2
NW1-8	**80**	**75**	N/A	**75**	4.8
NW1-9	**81**	**76**	N/A	**76**	5.1
NW2-1	**77**	**71**	**73**	**75**	1.7
NW2-2	**79**	**73**	**74**	**76**	2.1
NW2-3	**79**	**74**	**75**	**77**	2.0
NW2-4	**77**	**74**	N/A	**74**	3.5
NW2-5	**77**	**73**	N/A	**73**	4.5
NW2-6	**75**	**72**	N/A	**72**	3.3
NW2-7	**74**	**71**	N/A	**71**	3.4
NW2-8	**80**	**74**	**73**	**77**	3.3
NW2-9	**76**	**69**	**74**	**75**	1.6
NW3-1	**73**	**66**	**70**	**72**	1.9
NW3-2	**73**	65	**70**	**71**	2.1
NW3-3	**75**	**69**	**71**	**73**	1.8
NW3-4	**77**	**70**	**73**	**75**	2.7
NW3-5	**78**	**72**	**72**	**75**	3.1
NW3-6	**72**	**69**	N/A	**69**	3.0
NW3-7	**72**	**69**	N/A	**69**	3.0
NW3-8	**71**	**69**	N/A	**69**	2.2
NW3-9	**76**	**70**	**71**	**73**	2.1
NW4-1	**75**	**69**	**70**	**72**	2.4
NW4-10	**69**	**67**	N/A	**67**	2.3
NW4-11	**69**	**67**	N/A	**67**	1.9
NW4-2	**74**	**67**	**70**	**71**	2.7
NW4-3	**76**	**71**	**71**	**74**	2.6
NW4-4	**76**	**71**	**70**	**73**	2.1
NW4-5	**74**	**70**	**68**	**72**	1.8
NW4-6	**68**	64	62	**66**	1.9
NW4-7	**68**	64	N/A	64	3.6

Site	Combined 1999 No Wall[1] (dBA)	Scenario 2			
		1999 Direct Path With Wall (dBA)	1999 Reflected Path With Wall (dBA)	1999 Combined Noise (dBA)	Noise Reduction
NW4-8	**71**	**68**	N/A	**68**	3.5
NW4-9	**70**	**67**	N/A	**67**	3.0
NW5-1	**74**	**69**	**69**	**72**	2.1
NW5-2	**75**	**69**	**69**	**72**	2.5
NW5-3	**73**	**68**	**67**	**71**	1.9
NW5-4	**70**	**66**	64	**68**	1.9
NW5-5	**68**	**66**	N/A	66	2.3
NW5-6	**67**	64	N/A	64	2.7
Total Reductions Greater Than Scenario 1:					**27**

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

N/A – Not applicable, no reflected noise at this location.

[1] – From Table L-2.

Table L-4: Comparison of Total Additional Noise Reduction Provided by Acoustax Absorptive Materials (NW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	**83**	**81**	1.7	**80**	3.5	**79**	3.7
NW1-1	**82**	**80**	1.7	**78**	3.8	**78**	3.7
NW1-10	**81**	**77**	4.4	65	15.9	**81**	0.0
NW1-2	**83**	**81**	1.7	**79**	4.0	**79**	3.2
NW1-3	**83**	**81**	2.3	**78**	5.4	**80**	2.7
NW1-4	**85**	**81**	4.4	**76**	8.8	**82**	2.7
NW1-5	**84**	**79**	5.0	**73**	10.6	**81**	2.3
NW1-6	**82**	**77**	4.6	**66**	16.1	**82**	0.0
NW1-7	**82**	**76**	6.2	64	17.7	**82**	0.0
NW1-8	**80**	**75**	4.8	64	16.3	**80**	0.0
NW1-9	**81**	**76**	5.1	64	16.6	**81**	0.0
NW2-1	**77**	**75**	1.7	**73**	3.8	**73**	3.2
NW2-2	**79**	**76**	2.1	**74**	4.1	**75**	3.2
NW2-3	**79**	**77**	2.0	**75**	4.4	**75**	3.7
NW2-4	**77**	**74**	3.5	62	15.0	**77**	0.0
NW2-5	**77**	**73**	4.5	61	16.0	**77**	0.0
NW2-6	**75**	**72**	3.3	60	14.8	**75**	0.0
NW2-7	**74**	**71**	3.4	59	14.9	**74**	0.0
NW2-8	**80**	**77**	3.3	**74**	6.5	**76**	3.7
NW2-9	**76**	**75**	1.6	**74**	2.7	**72**	4.7
NW3-1	**73**	**72**	1.9	**70**	3.1	**69**	4.7
NW3-2	**73**	**71**	2.1	**70**	3.2	**68**	5.3
NW3-3	**75**	**73**	1.8	**71**	3.8	**71**	3.7
NW3-4	**77**	**75**	2.7	**73**	4.6	**73**	4.7
NW3-5	**78**	**75**	3.1	**72**	5.7	**74**	3.7
NW3-6	**72**	**69**	3.0	58	14.5	**72**	0.0

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-7	**72**	**69**	3.0	58	14.5	**72**	0.0
NW3-8	**71**	**69**	2.2	57	13.7	**71**	0.0
NW3-9	**76**	**73**	2.1	**71**	4.4	**72**	3.2
NW4-1	**75**	**72**	2.4	**70**	4.5	**71**	4.2
NW4-10	**69**	**67**	2.3	55	13.8	**69**	0.0
NW4-11	**69**	**67**	1.9	56	13.4	**69**	0.0
NW4-2	**74**	**71**	2.7	**70**	4.3	**69**	5.3
NW4-3	**76**	**74**	2.6	**71**	5.3	**72**	3.7
NW4-4	**76**	**73**	2.1	**70**	5.3	**72**	3.2
NW4-5	**74**	**72**	1.8	**68**	5.2	**71**	2.3
NW4-6	**68**	**66**	1.9	62	6.0	**66**	1.9
NW4-7	**68**	64	3.6	53	15.1	**68**	0.0
NW4-8	**71**	**68**	3.5	56	15.0	**71**	0.0
NW4-9	**70**	**67**	3.0	56	14.5	**70**	0.0
NW5-1	**74**	**72**	2.1	**70**	4.5	**70**	3.7
NW5-2	**75**	**72**	2.5	**69**	5.6	**71**	3.2
NW5-3	**73**	**71**	1.9	**68**	4.8	**69**	3.2
NW5-4	**70**	**68**	1.9	64	6.1	**68**	1.9
NW5-5	**68**	**66**	2.3	54	13.8	**68**	0.0
NW5-6	**67**	64	2.7	53	14.2	**67**	0.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-4 Cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	**83**	**77**	5.7	**70**	13.2
NW1-1	**82**	**77**	5.0	**69**	13.1
NW1-10	**81**	**77**	4.4	65	15.9
NW1-2	**83**	**78**	5.0	**69**	13.2
NW1-3	**83**	**78**	4.6	**69**	13.7
NW1-4	**85**	**79**	5.9	**69**	15.8
NW1-5	**84**	**78**	6.0	**67**	16.4
NW1-6	**82**	**77**	4.6	**66**	16.1
NW1-7	**82**	**76**	6.2	64	17.7
NW1-8	**80**	**75**	4.8	64	16.3
NW1-9	**81**	**76**	5.1	64	16.6
NW2-1	**77**	**71**	5.1	63	13.2
NW2-2	**79**	**73**	5.5	65	13.5
NW2-3	**79**	**74**	5.0	**66**	13.4
NW2-4	**77**	**74**	3.5	62	15.0
NW2-5	**77**	**73**	4.5	61	16.0
NW2-6	**75**	**72**	3.3	60	14.8
NW2-7	**74**	**71**	3.4	59	14.9
NW2-8	**80**	**75**	5.5	65	14.7
NW2-9	**76**	**70**	6.6	63	13.0
NW3-1	**73**	**66**	7.0	60	13.4
NW3-2	**73**	**66**	7.6	60	13.6
NW3-3	**75**	**70**	5.4	62	13.3
NW3-4	**77**	**71**	6.6	63	14.2
NW3-5	**78**	**72**	5.9	64	14.6

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	**69**	3.0	58	14.5
NW3-7	**72**	**69**	3.0	58	14.5
NW3-8	**71**	**69**	2.2	57	13.7
NW3-9	**76**	**70**	5.4	62	13.6
NW4-1	**75**	**69**	5.8	61	13.9
NW4-10	**69**	**67**	2.3	55	13.8
NW4-11	**69**	**67**	1.9	56	13.4
NW4-2	**74**	**67**	7.1	60	14.2
NW4-3	**76**	**71**	5.3	62	14.1
NW4-4	**76**	**71**	4.4	62	13.6
NW4-5	**74**	**70**	3.8	60	13.2
NW4-6	**68**	65	3.6	55	13.4
NW4-7	**68**	64	3.6	53	15.1
NW4-8	**71**	**68**	3.5	56	15.0
NW4-9	**70**	**67**	3.0	56	14.5
NW5-1	**74**	**69**	5.2	61	13.6
NW5-2	**75**	**70**	4.9	61	14.0
NW5-3	**73**	**68**	4.5	59	13.4
NW5-4	**70**	**67**	3.6	57	13.4
NW5-5	**68**	**66**	2.3	54	13.8
NW5-6	**67**	64	2.7	53	14.2

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-5: Comparison of Total Additional Noise Reduction Provided by Sound Fighter Systems Absorptive Materials (NW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	**83**	81	1.7	80	3.5	79	3.7
NW1-1	**82**	80	1.7	78	3.8	78	3.7
NW1-10	**81**	77	4.4	65	15.9	81	0.0
NW1-2	**83**	81	1.7	79	4.0	79	3.2
NW1-3	**83**	81	2.3	78	5.4	80	2.7
NW1-4	**85**	81	4.4	76	8.8	82	2.7
NW1-5	**84**	79	5.0	73	10.6	81	2.3
NW1-6	**82**	77	4.6	66	16.1	82	0.0
NW1-7	**82**	76	6.2	64	17.7	82	0.0
NW1-8	**80**	75	4.8	64	16.3	80	0.0
NW1-9	**81**	76	5.1	64	16.6	81	0.0
NW2-1	**77**	75	1.7	73	3.8	73	3.2
NW2-2	**79**	76	2.1	74	4.1	75	3.2
NW2-3	**79**	77	2.0	75	4.4	75	3.7
NW2-4	**77**	74	3.5	62	15.0	77	0.0
NW2-5	**77**	73	4.5	61	16.0	77	0.0
NW2-6	**75**	72	3.3	60	14.8	75	0.0
NW2-7	**74**	71	3.4	59	14.9	74	0.0
NW2-8	**80**	77	3.3	74	6.5	76	3.7
NW2-9	**76**	75	1.6	74	2.7	72	4.7
NW3-1	**73**	72	1.9	70	3.1	69	4.7
NW3-2	**73**	71	2.1	70	3.2	68	5.3
NW3-3	**75**	73	1.8	71	3.8	71	3.7
NW3-4	**77**	75	2.7	73	4.6	73	4.7
NW3-5	**78**	75	3.1	72	5.7	74	3.7

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	69	3.0	58	14.5	72	0.0
NW3-7	**72**	69	3.0	58	14.5	72	0.0
NW3-8	**71**	69	2.2	57	13.7	71	0.0
NW3-9	**76**	73	2.1	71	4.4	72	3.2
NW4-1	**75**	72	2.4	70	4.5	71	4.2
NW4-10	**69**	67	2.3	55	13.8	69	0.0
NW4-11	**69**	67	1.9	56	13.4	69	0.0
NW4-2	**74**	71	2.7	70	4.3	69	5.3
NW4-3	**76**	74	2.6	71	5.3	72	3.7
NW4-4	**76**	73	2.1	70	5.3	72	3.2
NW4-5	**74**	72	1.8	68	5.2	71	2.3
NW4-6	**68**	66	1.9	62	6.0	66	1.9
NW4-7	**68**	64	3.6	53	15.1	68	0.0
NW4-8	**71**	68	3.5	56	15.0	71	0.0
NW4-9	**70**	67	3.0	56	14.5	70	0.0
NW5-1	**74**	72	2.1	70	4.5	70	3.7
NW5-2	**75**	72	2.5	69	5.6	71	3.2
NW5-3	**73**	71	1.9	68	4.8	69	3.2
NW5-4	**70**	68	1.9	64	6.1	68	1.9
NW5-5	**68**	66	2.3	54	13.8	68	0.0
NW5-6	**67**	64	2.7	53	14.2	67	0.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-5 cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	**83**	77	5.7	**70**	13.2
NW1-1	**82**	77	5.0	**69**	13.1
NW1-10	**81**	77	4.4	65	15.9
NW1-2	**83**	78	5.0	**69**	13.2
NW1-3	**83**	78	4.6	**69**	13.7
NW1-4	**85**	79	5.9	**69**	15.8
NW1-5	**84**	78	6.0	**67**	16.4
NW1-6	**82**	77	4.6	66	16.1
NW1-7	**82**	76	6.2	64	17.7
NW1-8	**80**	75	4.8	64	16.3
NW1-9	**81**	76	5.1	64	16.6
NW2-1	**77**	71	5.1	**63**	13.2
NW2-2	**79**	73	5.5	**65**	13.5
NW2-3	**79**	74	5.0	**66**	13.4
NW2-4	**77**	74	3.5	62	15.0
NW2-5	**77**	73	4.5	61	16.0
NW2-6	**75**	72	3.3	60	14.8
NW2-7	**74**	71	3.4	59	14.9
NW2-8	**80**	75	5.5	**65**	14.7
NW2-9	**76**	70	6.6	**63**	13.0
NW3-1	**73**	66	7.0	**60**	13.4
NW3-2	**73**	66	7.6	**60**	13.6
NW3-3	**75**	70	5.4	**62**	13.3
NW3-4	**77**	71	6.6	**63**	14.2
NW3-5	**78**	72	5.9	**64**	14.6

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	69	3.0	58	14.5
NW3-7	**72**	69	3.0	58	14.5
NW3-8	**71**	69	2.2	57	13.7
NW3-9	**76**	70	5.4	**62**	13.6
NW4-1	**75**	69	5.8	**61**	13.9
NW4-10	**69**	67	2.3	55	13.8
NW4-11	**69**	67	1.9	56	13.4
NW4-2	**74**	67	7.1	**60**	14.2
NW4-3	**76**	71	5.3	**62**	14.1
NW4-4	**76**	71	4.4	**62**	13.6
NW4-5	**74**	70	3.8	**60**	13.2
NW4-6	**68**	65	3.6	**55**	13.4
NW4-7	**68**	64	3.6	53	15.1
NW4-8	**71**	68	3.5	56	15.0
NW4-9	**70**	67	3.0	56	14.5
NW5-1	**74**	69	5.2	**61**	13.6
NW5-2	**75**	70	4.9	**61**	14.0
NW5-3	**73**	68	4.5	**59**	13.4
NW5-4	**70**	67	3.6	**57**	13.4
NW5-5	**68**	66	2.3	54	13.8
NW5-6	**67**	64	2.7	53	14.2

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-6: Comparison of Total Additional Noise Reduction Provided by Carsonite Composite Panels Absorptive Materials (NW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	83	81	1.7	81	2.6	82	1.6
NW1-1	82	80	1.7	79	2.7	81	1.6
NW1-10	81	77	4.4	74	7.4	81	0.0
NW1-2	83	81	1.7	80	2.8	81	1.4
NW1-3	83	81	2.3	79	3.7	82	1.2
NW1-4	85	81	4.4	79	6.2	84	1.2
NW1-5	84	79	5.0	76	7.1	82	1.1
NW1-6	82	77	4.6	74	7.6	82	0.0
NW1-7	82	76	6.2	73	9.2	82	0.0
NW1-8	80	75	4.8	72	7.8	80	0.0
NW1-9	81	76	5.1	73	8.1	81	0.0
NW2-1	77	75	1.7	74	2.7	75	1.4
NW2-2	79	76	2.1	75	3.0	77	1.4
NW2-3	79	77	2.0	76	3.1	78	1.6
NW2-4	77	74	3.5	70	6.5	77	0.0
NW2-5	77	73	4.5	69	7.5	77	0.0
NW2-6	75	72	3.3	69	6.3	75	0.0
NW2-7	74	71	3.4	68	6.4	74	0.0
NW2-8	80	77	3.3	75	4.7	79	1.6
NW2-9	76	75	1.6	74	2.2	75	1.9
NW3-1	73	72	1.9	71	2.5	72	1.9
NW3-2	73	71	2.1	71	2.7	71	2.1
NW3-3	75	73	1.8	72	2.8	74	1.6
NW3-4	77	75	2.7	74	3.6	76	1.9
NW3-5	78	75	3.1	74	4.3	77	1.6

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	**69**	3.0	**66**	6.0	**72**	0.0
NW3-7	**72**	**69**	3.0	**66**	6.0	**72**	0.0
NW3-8	**71**	**69**	2.2	**66**	5.2	**71**	0.0
NW3-9	**76**	**73**	2.1	**72**	3.2	**74**	1.4
NW4-1	**75**	**72**	2.4	**71**	3.4	**73**	1.8
NW4-10	**69**	**67**	2.3	64	5.3	**69**	0.0
NW4-11	**69**	**67**	1.9	64	4.9	**69**	0.0
NW4-2	**74**	**71**	2.7	**71**	3.5	**72**	2.1
NW4-3	**76**	**74**	2.6	**72**	3.9	**75**	1.6
NW4-4	**76**	**73**	2.1	**72**	3.5	**74**	1.4
NW4-5	**74**	**72**	1.8	**70**	3.3	**72**	1.1
NW4-6	**68**	**66**	1.9	65	3.6	**67**	0.9
NW4-7	**68**	64	3.6	61	6.6	**68**	0.0
NW4-8	**71**	**68**	3.5	64	6.5	**71**	0.0
NW4-9	**70**	**67**	3.0	64	6.0	**70**	0.0
NW5-1	**74**	**72**	2.1	**71**	3.2	**73**	1.6
NW5-2	**75**	**72**	2.5	**71**	3.9	**73**	1.4
NW5-3	**73**	**71**	1.9	**69**	3.2	**71**	1.4
NW5-4	**70**	**68**	1.9	**66**	3.7	**69**	0.9
NW5-5	**68**	**66**	2.3	63	5.3	**68**	0.0
NW5-6	**67**	64	2.7	61	5.7	**67**	0.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-6 cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	**83**	**80**	3.4	**78**	4.7
NW1-1	**82**	**79**	3.1	**77**	4.7
NW1-10	**81**	**77**	4.4	**74**	7.4
NW1-2	**83**	**79**	3.2	**78**	4.8
NW1-3	**83**	**80**	3.4	**78**	5.3
NW1-4	**85**	**80**	5.1	**78**	7.4
NW1-5	**84**	**78**	5.5	**76**	8.0
NW1-6	**82**	**77**	4.6	**74**	7.6
NW1-7	**82**	**76**	6.2	**73**	9.2
NW1-8	**80**	**75**	4.8	**72**	7.8
NW1-9	**81**	**76**	5.1	**73**	8.1
NW2-1	**77**	**73**	3.2	**72**	4.7
NW2-2	**79**	**75**	3.6	**73**	5.1
NW2-3	**79**	**76**	3.3	**74**	5.0
NW2-4	**77**	**74**	3.5	**70**	6.5
NW2-5	**77**	**73**	4.5	**69**	7.5
NW2-6	**75**	**72**	3.3	**69**	6.3
NW2-7	**74**	**71**	3.4	**68**	6.4
NW2-8	**80**	**76**	4.3	**74**	6.3
NW2-9	**76**	**73**	3.6	**72**	4.6
NW3-1	**73**	**70**	3.9	**69**	4.9
NW3-2	**73**	**69**	4.3	**68**	5.2
NW3-3	**75**	**72**	3.4	**70**	4.8
NW3-4	**77**	**73**	4.4	**72**	5.8
NW3-5	**78**	**74**	4.4	**72**	6.1

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	**69**	3.0	**66**	6.0
NW3-7	**72**	**69**	3.0	**66**	6.0
NW3-8	**71**	**69**	2.2	**66**	5.2
NW3-9	**76**	**72**	3.6	**70**	5.2
NW4-1	**75**	**71**	3.9	**69**	5.4
NW4-10	**69**	**67**	2.3	64	5.3
NW4-11	**69**	**67**	1.9	64	4.9
NW4-2	**74**	**70**	4.5	**68**	5.7
NW4-3	**76**	**72**	3.9	**71**	5.6
NW4-4	**76**	**72**	3.2	**70**	5.1
NW4-5	**74**	**71**	2.7	**69**	4.8
NW4-6	**68**	65	2.7	63	4.9
NW4-7	**68**	64	3.6	61	6.6
NW4-8	**71**	**68**	3.5	64	6.5
NW4-9	**70**	**67**	3.0	64	6.0
NW5-1	**74**	**71**	3.5	**69**	5.1
NW5-2	**75**	**71**	3.6	**69**	5.5
NW5-3	**73**	**69**	3.1	**68**	4.9
NW5-4	**70**	**67**	2.7	65	4.9
NW5-5	**68**	**66**	2.3	63	5.3
NW5-6	**67**	64	2.7	61	5.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-7: Comparison of Total Additional Noise Reduction Provided by Noiseshield Type FS Absorptive Materials (NW Quadrant)

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	83	81	1.7	80	3.4	80	3.6
NW1-1	82	80	1.7	78	3.8	79	3.6
NW1-10	81	77	4.4	66	15.4	81	0.0
NW1-2	83	81	1.7	79	4.0	79	3.1
NW1-3	83	81	2.3	78	5.4	80	2.7
NW1-4	85	81	4.4	76	8.7	82	2.7
NW1-5	84	79	5.0	73	10.5	81	2.3
NW1-6	82	77	4.6	66	15.6	82	0.0
NW1-7	82	76	6.2	65	17.2	82	0.0
NW1-8	80	75	4.8	64	15.8	80	0.0
NW1-9	81	76	5.1	65	16.1	81	0.0
NW2-1	77	75	1.7	73	3.8	73	3.1
NW2-2	79	76	2.1	74	4.1	75	3.1
NW2-3	79	77	2.0	75	4.3	76	3.6
NW2-4	77	74	3.5	62	14.5	77	0.0
NW2-5	77	73	4.5	61	15.5	77	0.0
NW2-6	75	72	3.3	61	14.3	75	0.0
NW2-7	74	71	3.4	60	14.4	74	0.0
NW2-8	80	77	3.3	74	6.5	77	3.6
NW2-9	76	75	1.6	74	2.7	72	4.7
NW3-1	73	72	1.9	70	3.1	69	4.7
NW3-2	73	71	2.1	70	3.2	68	5.2
NW3-3	75	73	1.8	71	3.8	72	3.6
NW3-4	77	75	2.7	73	4.6	73	4.7
NW3-5	78	75	3.1	72	5.7	75	3.6

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels Only		Absorptive Wall Panels Only		Absorptive Materials on the Upper Deck Only	
		1999[2] (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	**69**	3.0	58	14.0	**72**	0.0
NW3-7	**72**	**69**	3.0	58	14.0	**72**	0.0
NW3-8	**71**	**69**	2.2	58	13.2	**71**	0.0
NW3-9	**76**	**73**	2.1	**71**	4.4	**72**	3.1
NW4-1	**75**	**72**	2.4	**70**	4.5	**71**	4.1
NW4-10	**69**	**67**	2.3	56	13.3	**69**	0.0
NW4-11	**69**	**67**	1.9	56	12.9	**69**	0.0
NW4-2	**74**	**71**	2.7	**70**	4.2	**69**	5.2
NW4-3	**76**	**74**	2.6	**71**	5.3	**73**	3.6
NW4-4	**76**	**73**	2.1	**70**	5.2	**72**	3.1
NW4-5	**74**	**72**	1.8	**68**	5.2	**71**	2.3
NW4-6	**68**	**66**	1.9	62	5.9	**66**	1.9
NW4-7	**68**	64	3.6	53	14.6	**68**	0.0
NW4-8	**71**	**68**	3.5	56	14.5	**71**	0.0
NW4-9	**70**	**67**	3.0	56	14.0	**70**	0.0
NW5-1	**74**	**72**	2.1	**70**	4.4	**71**	3.6
NW5-2	**75**	**72**	2.5	**69**	5.5	**71**	3.1
NW5-3	**73**	**71**	1.9	**68**	4.8	**69**	3.1
NW5-4	**70**	**68**	1.9	64	6.0	**68**	1.9
NW5-5	**68**	**66**	2.3	55	13.3	**68**	0.0
NW5-6	**67**	64	2.7	53	13.7	**67**	0.0

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3).

Table L-7 cont'd

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
M-16	**83**	**77**	5.6	**70**	12.7
NW1-1	**82**	**77**	5.0	**69**	12.7
NW1-10	**81**	**77**	4.4	**66**	15.4
NW1-2	**83**	**78**	4.9	**70**	12.8
NW1-3	**83**	**78**	4.5	**70**	13.3
NW1-4	**85**	**79**	5.9	**70**	15.4
NW1-5	**84**	**78**	5.9	**68**	16.0
NW1-6	**82**	**77**	4.6	**66**	15.6
NW1-7	**82**	**76**	6.2	65	17.2
NW1-8	**80**	**75**	4.8	64	15.8
NW1-9	**81**	**76**	5.1	65	16.1
NW2-1	**77**	**71**	5.1	64	12.7
NW2-2	**79**	**73**	5.5	65	13.1
NW2-3	**79**	**74**	4.9	**66**	13.0
NW2-4	**77**	**74**	3.5	62	14.5
NW2-5	**77**	**73**	4.5	61	15.5
NW2-6	**75**	**72**	3.3	61	14.3
NW2-7	**74**	**71**	3.4	60	14.4
NW2-8	**80**	**75**	5.5	**66**	14.3
NW2-9	**76**	**70**	6.6	64	12.6
NW3-1	**73**	**67**	6.9	60	13.0
NW3-2	**73**	**66**	7.5	60	13.2
NW3-3	**75**	**70**	5.3	62	12.8
NW3-4	**77**	**71**	6.5	64	13.8
NW3-5	**78**	**72**	5.9	64	14.1

Site	1999 Without Wall[1] (dBA)	Reflective Wall Panels + Absorptive Materials on the Upper Deck		Absorptive Wall Panels + Absorptive Materials on the Upper Deck	
		1999 (dBA)	Overall Noise Reduction (dBA)	1999 (dBA)	Overall Noise Reduction (dBA)
NW3-6	**72**	**69**	3.0	58	14.0
NW3-7	**72**	**69**	3.0	58	14.0
NW3-8	**71**	**69**	2.2	58	13.2
NW3-9	**76**	**70**	5.3	62	13.2
NW4-1	**75**	**69**	5.7	61	13.4
NW4-10	**69**	**67**	2.3	56	13.3
NW4-11	**69**	**67**	1.9	56	12.9
NW4-2	**74**	**67**	7.0	60	13.8
NW4-3	**76**	**71**	5.3	62	13.6
NW4-4	**76**	**71**	4.4	62	13.1
NW4-5	**74**	**70**	3.8	61	12.8
NW4-6	**68**	65	3.5	55	12.9
NW4-7	**68**	64	3.6	53	14.6
NW4-8	**71**	**68**	3.5	56	14.5
NW4-9	**70**	**67**	3.0	56	14.0
NW5-1	**74**	**69**	5.1	61	13.1
NW5-2	**75**	**70**	4.9	61	13.5
NW5-3	**73**	**68**	4.4	60	13.0
NW5-4	**70**	**67**	3.6	57	13.0
NW5-5	**68**	**66**	2.3	55	13.3
NW5-6	**67**	64	2.7	53	13.7

Bold numbers indicate modeled values that approach or exceed the Noise Abatement Criteria (NAC) of 67 dBA.

[1] – From Table L-2.

[2] – From Scenario 1 (Table L-3)..

APPENDIX M: Residential Equivalency Calculations

Residential Equivalency for Ship Canal Bridge

Tyee Yacht Club

The Tyee Yacht Club site includes a small outdoor deck area that is used by a catering service, called Ravishing Radish. The community uses ravishing Radish facilities approximately three times per week for weddings or other events during warmer months. During cooler months, it is used about once per week. It is estimated by the catering staff (personal communication), that approximately 150 people use the facilities per event. Each event lasts four to eight hours (six hours average), and events occur on weekends only.

Three events per weekend occur during summer months (assumed to be six months; April through September), and at the most, only one event occurs during winter months (assumed to be October through March).

The summer and winter use are different in the number of days used, so they were calculated separately and added together.

The analyst determined the summer usage factor for the outdoor area as follows:

- 9 hours (average each day)/24 hours per day = 0.38
- 2 day/7 days per week = 0.29
- 6 months/12 months = 0.5

Therefore: 0.38 x 0.29 x 0.5 = 0.06 usage factor. 150 average number of users per event x 0.06 = 9/3 people per household = 3.

The analyst determined the winter usage factor for the outdoor area as follows:

- 6 hours/24 hours per day = 0.25
- 1 day/7 days per week = 0.14
- 6 months/12 months per year = 0.5

Therefore: 0.25 x 0.14 x 0.5 = 0.02 usage factor. 150 average number of users per event x 0.02 = 3/3 people per household = 1 residential equivalency.

The Tyee Yacht Club facility represents **4 residential equivalencies**.

Pocock Rowing Center

The Pocock Rowing Center is used throughout the day by staff and people using indoor and outdoor facilities. Center staff (personal communication) state that the heaviest use is by rowing clubs in the early morning (5 a.m. to 8 a.m. and late afternoon (3 p.m. to 6 p.m.) hours. Between 10 a.m. and 3 p.m. the use is minimal. The Center facilities are used 12 months out of the year, but usage is lighter on weekends. Rowing club personnel estimates that up to 350 people use the facility five days per week for about nine months out of the year. During winter up to 250 people per day use the facility. On Saturdays the usage is approximately 100 fewer visitors, and on Sundays the use is minimal. The Center is closed on Sundays.

A weighted average for the number of users per day throughout the year was determined by considering winter and summer use. If 350 people use the facility daily for nine months per year and 250 use the facility daily for three months, then: 350 x 0.75 = 263, and 250 x 0.25 = 63, 263 + 63 = 326 weighted average throughout the year.

Since all people that use the facility are not on site at the same time, it was necessary to calculate how many might be on site at any given time; a “snapshot” view. So, to obtain a number of users that are on site at any given time, the average number of users was divided by the number of hours the site is used by those users: 326/13 hours (5 a.m. to 6 p.m.) = 25 users may be found on site (average).

The analyst determined the usage factor for the outdoor area as follows:

- 13 hours/24 hours per day = 0.54
- 6 days/7 days per week = 0.86
- 12 months/12 months = 1.0

Therefore: 0.54 x 0.86 x 1.0 = 0.46 usage factor. 25 users x 0.46 = 11.5, then 12/3 people per household: **4 residential equivalencies**.

John Stanford International School

The Federal Highway Administration, in the D22-22 guidance, provides a standard usage factor for schools. This factor is to be used with the number of users. All the children enrolled in the school will be on site at any given time.

There are 400 children enrolled in the school x 0.22 = 88/3 = **30 residential equivalencies**.